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Infantry Training

Volume II

INFANTRY HEAVY WEAPONS

PAMPHLET No. 24

THE MEDIUM MACHINE GUN
PART III—FIRE CONTROL

1951

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CONTENTS

CHAPTER 16.—GENERAL PRINCIPLES OF FIRE CONTROL

CHAPTER 17.—DIRECT FIRE

CHAPTER 18.—FLANKING AND OVERHEAD FIRE

CHAPTER 19.—PROTECTIVE FIRE—FIXED LINES

CHAPTER 20.—NIGHT FIRING

CHAPTER 21.—INDIRECT FIRE

CHAPTER 22.—MAP SHOOTING

1-2038

LIST OF PLATES

ABBREVIATIONS

The following abbreviations are used in this pamphlet:—

DP ... Drill pattern.
IA ... Immediate action.
MMG Medium machine gun.
MPI... Mean point of impact.
OP ... Observation post.
RAP Regimental aid post.
RV ... Rendezvous.
QE ... Quadrant elevation.

GLOSSARY OF TERMS USED IN THIS PAMPHLET

Angle of sight

The angle between the line of sight and the horizontal plane. The angle is said to be plus when the target is above the horizontal plane and minus when the target is below it.

Crest clearance angle

The angle by which the barrel must be raised above the line of sight to the crest to ensure that all the bullets will clear the crest.

Deflection

A lateral displacement of the lines of any, or all, guns.

Direct fire

When the gun is laid directly on the target by means of the backsight and foresight.

Fixed line

A term denoting that measures have been taken for maintaining elevation and direction in darkness etc, to ensure that fire will fall on the pre-arranged area of ground.

Flanking fire

Fire applied across the front of a locality occupied by own troops, or, if they are advancing, at an angle to their line of advance.

Ground angle

The angle between the line of sight to the target and the line of sight to own troops when using overhead fire.

Group commander

An officer or NCO commanding two or more machine gun sections.

Indirect fire

When a gun is laid to hit a given target by other means than by laying on it direct.

Line of fire

The direction of the target from the gun.

Minimum clearance

A term used to denote the minimum height of the centre bullet of the cone above the heads of our own troops for the latter to be safe.

Near limit of arc

The nearest line across the arc of fire on which fire may be required.

Overhead fire

Fire passing over the heads of our own troops.

Pivot gun

The gun used as a basis for calculation.

Quadrant angle

The angle which the axis of the barrel makes with the horizontal plane.

Quadrant elevation

The quadrant angle expressed in terms of a range and an angle of sight.

Registering

The recording of the direction and elevation necessary to hit any given target as found by ranging.

Safety angle for flanking fire

The minimum lateral angle by which fire must clear own troops for them to be safe.

Safety angle for overhead fire

The minimum angle which must be included between the axis of the barrel and the line of sight to own troops to ensure their safety under overhead fire.

Tangent angle

The angle which the axis of the barrel makes with the line of sight.

Zero line

A line of reference on which all guns are parallel and from which switches are measured.

RESTRICTED

Infantry Training

VOLUME II

INFANTRY HEAVY WEAPONS

PAMPHLET No. 24

The Medium Machine Gun
Part III—Fire Control

CHAPTER 16

GENERAL PRINCIPLES OF FIRE CONTROL

INTRODUCTORY NOTES

Introduction

1. The considerations which govern the methods of applying machine gun fire are:—

(a) The best fire effect on the whole target.
(b) Economy of time and ammunition.
(c) Simplicity and speed.
(d) Safety of our own troops.

The factor of surprise as applied to fire cannot be over-estimated.

Fire control orders must be framed in such a way that all these requirements are met.

The system of fire control laid down in this pamphlet is worked out on the above basis and should be adhered to. Occasionally the situation may not permit the rules given to be carried out in their entirety. Common sense and a knowledge of how the rules are arrived at will enable the best fire effect to be obtained.

Basis of fire control rules

2. Fire effect is desirable as soon as fire is opened or immediately after. Observation of machine gun fire is only possible on certain types of ground and, particularly in European countries, can never be relied on. The opportunity of correcting fire onto the target by observation of strike will seldom occur.

There is no quick and reliable means of determining with accuracy the effect of climatic conditions. Errors, both of direction and elevation, must therefore be expected. The procedure is to define round the target an area allowing for reasonable errors of direction and elevation, and to apply fire over the whole of this area.

The rules of fire control contained in the following chapters are based on the assumption that insufficient observation of strike will be obtained to deduce the exact positions of the beaten zones. Every endeavour, however, must be made to pick up the strike of the bullets and to correct fire accordingly. Whenever sufficient observation of fire for this purpose is possible, the fire control rules should not be adhered to.

Direct or indirect fire

3. The normal method of engaging a target will be by direct fire *ie*, by laying on the target over the sights. The main asset of direct fire is its extreme flexibility, which enables a succession of targets over a wide arc to be engaged quickly.

The machine gun is capable of firing indirect *ie*, the gun is laid on an aiming mark, with the elevation required to hit the target obtained and placed on the gun by means of instruments. Indirect fire is employed when it is impossible or inadvisable to occupy a direct fire position, or when shooting from the map.

The main technical advantage of indirect fire is that the necessity for indicating the target to a number of individuals is removed. The laying of the gun is mechanical and is not affected by light or distance.

The disadvantages are the necessity for additional measurements and calculations, and the difficulties of crest clearance owing to the flat trajectory.

Conditions which obstruct the field of view (*eg*, bad visibility, fog, smoke etc), often arise after a position is occupied. Consequently, when direct fire is to be employed, certain arrangements for indirect fire should be made as soon as time permits. The details of these arrangements can be found in Chapter 13.

The principles and details of fire control set down in this chapter apply equally to direct and indirect fire. As the methods of fire and details of fire discipline are in many instances not the same, direct and indirect fire are treated separately in Part II.

Lesson 93.—CHARACTERISTICS OF MACHINE GUN FIRE

A INSTRUCTOR'S NOTES

Aim

1. To teach the fire controller the special characteristics of MG fire and their effect on the employment of machine guns.

Class and instructors

2. One officer instructor and not more than 30 in the class.

Periods

3. One 45-minute period, lecture.

Stores

4. Blackboard and chalk. Class require range tables.

Preparation

5. Draw the diagrams given below.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para. I above).

7. Explain the Introductory Notes to the chapter.

Firing of the round

8. State that when the charge in the cartridge is fired, a pressure of 19½ tons per square inch is reached. The gases, building up this pressure very rapidly, hit the base of the bullet with a sharp blow and force it through the barrel.

9. During its passage through the barrel, the bullet is given a rotary movement by the rifling of the barrel, which causes the bullet to have a steady flight. The bullet leaves the barrel with a velocity of 2525 feet a second.

Trajectory

10. Explain that when the bullet leaves the barrel, two further forces act on it:—

(a) Air resistance.
(b) Gravity.

As air resistance overcomes the velocity that the bullet has received from the force of the explosion, gravity exerts an increasingly greater effect and causes the bullet to follow a curved path towards the earth. The path of the bullet is called its trajectory (*see* Fig 12).

The curvature of the trajectory becomes greater the further the bullet travels. The highest point on the trajectory is at a point approximately two-thirds of the range gun-target.

This is known as the " culminating point."

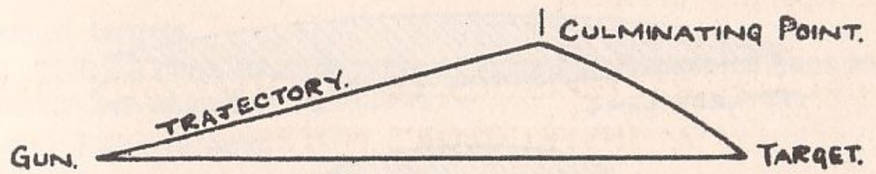


FIG 12

Burst of fire

11. State that a burst of machine gun fire is normally 25 rounds, though in emergency longer bursts may be used.

Cone of fire

12. Tell the class that owing to the slightly different elevation with which each bullet leaves the gun and owing to the general vibration of the gun on its tripod during firing, a burst of fire forms a pattern in the air, which is elliptical in shape if shown in the vertical plane. This pattern is called a cone of fire (*see* Fig 13). The majority of the shots are in the centre of the cone.

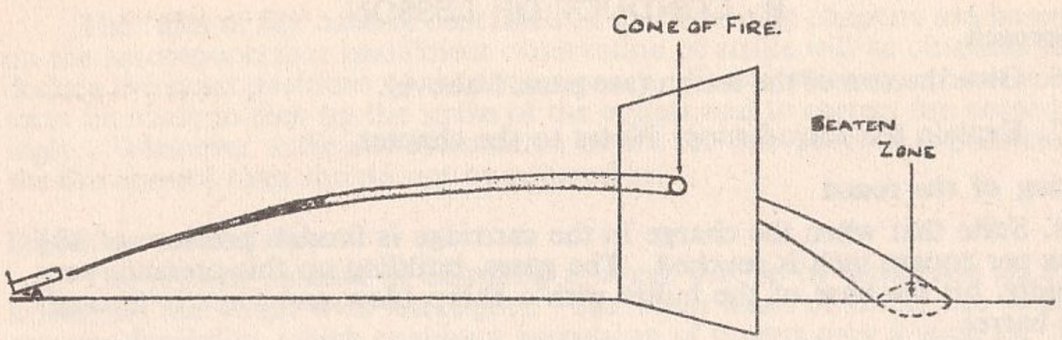


FIG 13

Beaten zone

13. Explain that when the cone of fire strikes the ground it forms a long cigar-shaped pattern. This pattern is known as the beaten zone. At shorter ranges the beaten zone, due to the flat trajectory, is very long and narrow. As the range increases up to 2000 yards, the length of the beaten zone decreases due to the increased trajectory and the steeper slope of the bullet. Over 2000 yards, the length of the beaten zone increases as small variations in the muzzle velocities of the bullets become more apparent.

The width of the beaten zone increases steadily with the range. The dimensions of beaten zones given in the range tables refer to fire falling on horizontal ground. Should the ground be falling, the beaten zones will be longer. Should the fire be falling on rising ground, the beaten zones will be shorter. The width is constant on all types of ground. *See* Figs 14 and 15.

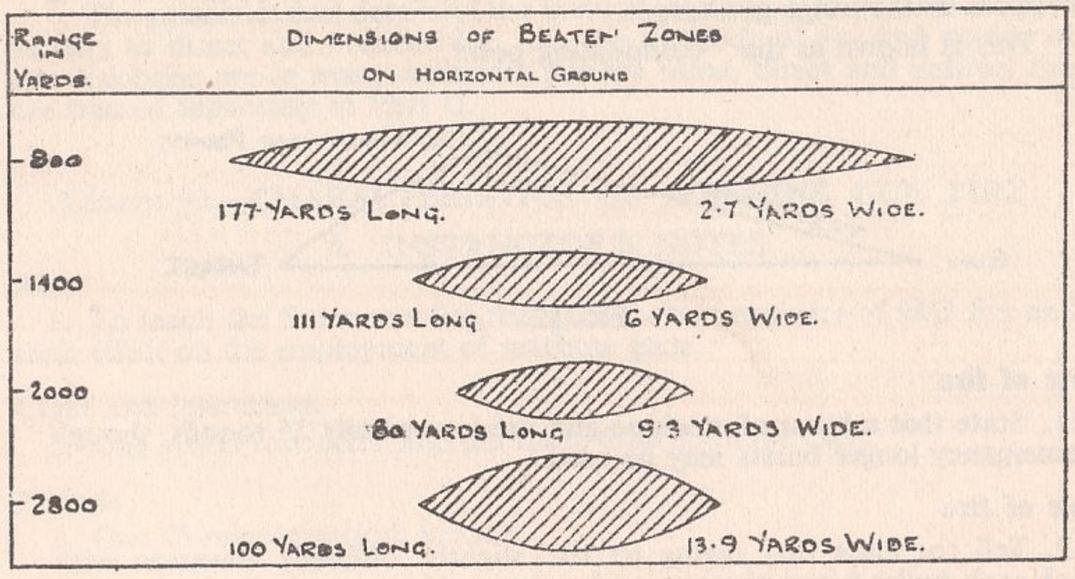


FIG 14

Lengths of beaten zones for varying degrees of rising ground are given in the range tables.

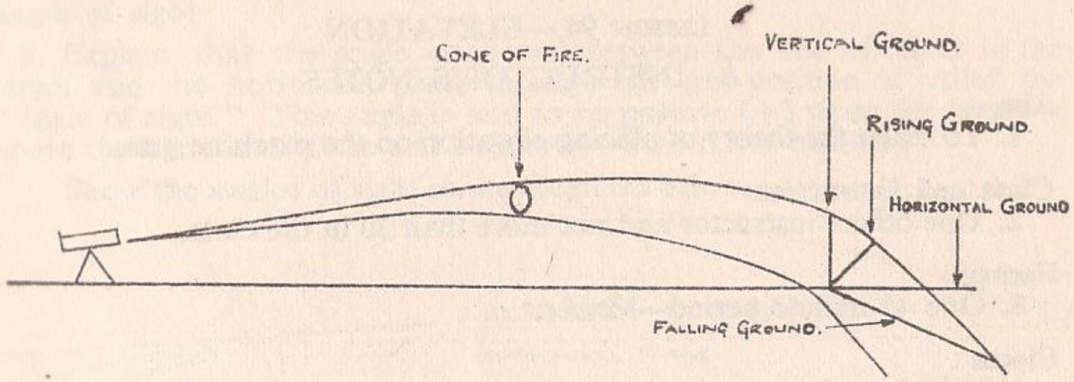


FIG 15

Plunging fire

14. The beaten zone will also be shortened if guns are fired on to a target on a lower level than the gun position. This is called plunging fire and should be avoided as it reduces the neutralizing effect of the machine gun.

Effect of trajectory and beaten zone on tactical employment

15. State that:—

(a) Owing to the flat trajectory of the gun at ranges up to about 600 yards, the machine gun is capable of laying a belt of fire 600 yards long on flat ground, the bullets never rising more than four feet above the ground. This is a valuable asset in defence.

(b) As it is obviously desirable to place the length of the beaten zone along the target when engaging wide targets, machine guns are best sited to a flank where they can employ enfilade fire.

Types of targets

16. Tell the class that the types of targets that machine guns are required to engage are classified as follows:—

(a) Point targets.

(b) Targets with width.

(c) Targets with depth.

(d) Moving targets.

The methods of engaging these types of targets are taught in later lessons.

Conclusion

17. Questions to and from class.

18. If facilities are available, beaten zones can be demonstrated by firing onto ground or water that will show the strike of the bullets.

19. Sum up main points.

LESSON 94.—ELEVATION

A INSTRUCTOR'S NOTES

Aim

1. To teach the theory of placing elevation on the machine gun.

Class and instructors

2. One officer instructor and not more than 30 in the class.

Periods

3. One 45-minute period—lecture.

Stores

4. Blackboard, gun, tripod and dial sight.

Preparation

5. Draw the diagrams shown below on the blackboard. Mount the gun in a position where it can be seen by the class.

B CONDUCT OF LESSON

Approach

6. Explain the aim of lesson (*see* para 1 above).

7. Emphasize the necessity of being quite clear as to the various angles involved in elevation as they will be constantly referred to when dealing with indirect fire and safety.

Tangent angle

8. Choose a point on the wall on the same level as the gun and tell the class to imagine that the mark is a target at a range of, say, 1000 yards.

Run the slide on the tangent sight up to 1000 and lay the gun on the target by means of the handwheel. Point out to the class that an angle has been made between the axis of the barrel and the line of sight through the backsight and foresight to the target. The process of setting the slide and laying the line of sight onto the target sets the axis of the barrel at an angle above the line of sight. This angle is the "tangent angle" for the range at which the target lies (but *see* para 11 page 8).

Tangent angles for all ranges have been determined and are laid down in the range tables.

Confirm that the squad fully understand the tangent angle by revising with the diagram on the blackboard.

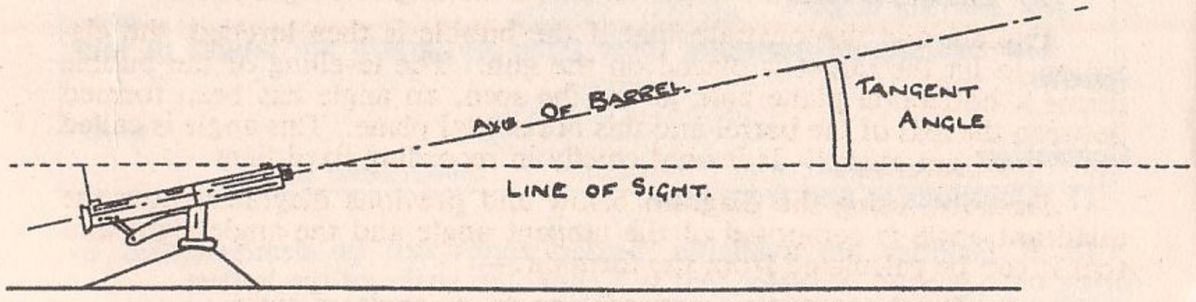
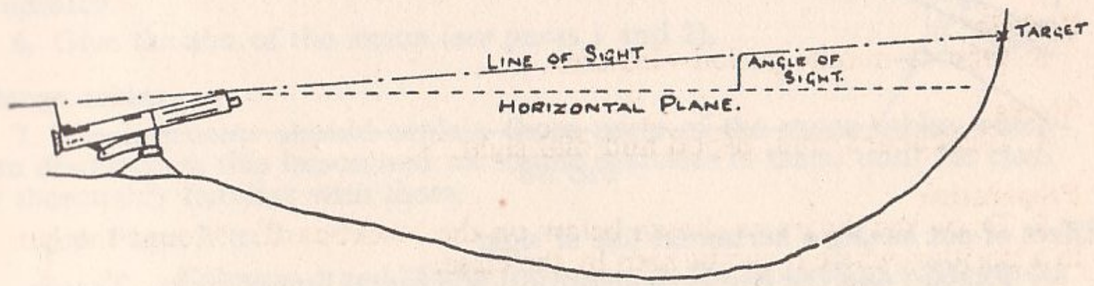


FIG 16

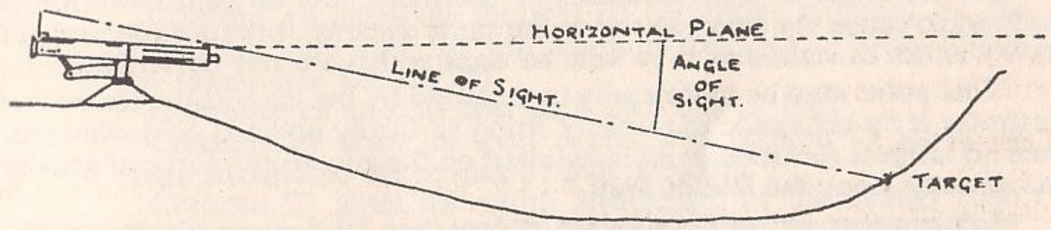
Angle of sight

9. Explain that the angle contained between the line of sight to the target and the horizontal plane through the gun position is called the "angle of sight." This angle is said to be positive (+) when the target is above the horizontal plane and negative (−) when it is below it.

Show the angles of sight in the diagrams below.



Positive angle of sight.



Negative angle of sight.

FIG 17

Quadrant angle

10. Explain that, when firing indirect, elevation is placed on the gun by means of the dial sight, in two components:—

(a) The range (tangent angle) on the range drum.

(b) The angle of sight to the target on the angle of sight drum.

Explain and demonstrate that if the bubble is then levelled, the elevation to hit the target is placed on the gun. The levelling of the bubble forms a horizontal plane and, as can be seen, an angle has been formed between the axis of the barrel and this horizontal plane. This angle is called the "quadrant angle." It is used chiefly in recording fixed lines.

Describe, using the diagram below and previous diagrams, how the quadrant angle is composed of the tangent angle and the angle sight and that it can be calculated from the formula:—

Quadrant angle = tangent angle ± angle of sight.

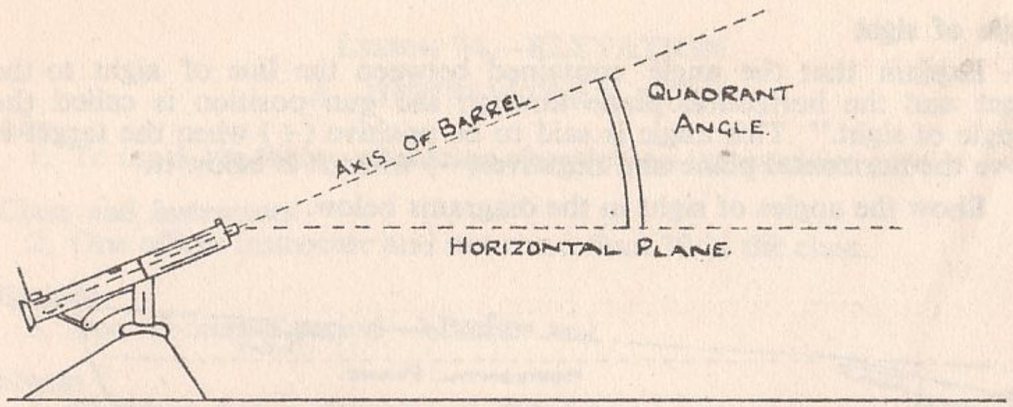


FIG 18

Effect of not having a horizontal line of sight

11. Explain that the gun is sighted for a horizontal line of sight. That is to say, if the tangent sight is set at a certain graduation and the gun laid with a horizontal line of sight, a single shot will in theory strike the horizontal plane at a distance away from the gun corresponding to the graduation at which the sight is set.

As the angle of sight increases or decreases, less tangent elevation is required to cause the bullet to travel the same distance, because the force of gravity is not at right angles to lines of sight which are not horizontal.

This point may be more easily understood by the class if the instructor illustrates it by giving the example of firing vertically upward or downward. Here no tangent elevation at all is required on the gun, as the force of gravity acts directly along the line of sight.

Explain that for angles of sight of less than 10 degrees alteration, the alteration in tangent angle required is negligible. In mountainous countries, however, it will be necessary to set the sight at a corrected range. A chart from which the corrected range for abnormal angles of sight can be obtained is given in the range tables.

Conclusion

12. Questions to and from class. The class can be questioned as to the various angles of elevation by drawing diagrams on the board and getting the class to name the angles.

13. Sum up main points.

LESSON 95.—RANGE TABLE AND CLIMATIC INFLUENCES

A INSTRUCTOR'S NOTES

Aim

1. To teach the fire controller the use of the range tables.

2. To teach the fire controller how to off-set the effect of climatic conditions on elevation and direction.

Class and instructors

3. One officer instructor and not more than 30 in the class.

Periods

4. One 45-minute period, lecture.

Stores

5. Blackboard and chalk. Class will require range tables.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* paras 1 and 2).

Range tables

7. The instructor should explain those parts of the range tables which are described in this lesson and set simple exercises in them, until the class is thoroughly familiar with them.

(a) Pages 2 to 7

Columns 1 and 26 give the ranges in 50's from 50 to 4,500 yards.

Column 2 gives the tangent angles.

Column 3 gives the lifts for 50 yards, *ie*, the angular amount by which each elevation has to be increased so as to add 50 yards to the range.

Columns 5 to 13 (*see* para 9 *(c)* below).

Column 14 gives the number of elevations required by the combined sight rule for the different methods of determining the range (*see* Lesson 96).

Columns 19 and 20 deal with the cone of fire.

Column 20 gives its total depth, and column 19 gives the angle subtended at the gun by half its depth.

Column 21 gives the width and length of the beaten zone. The figures given are for 90 per cent of the total shots fired. The stray shots, which produce little fire effect, are therefore not included. The length of beaten zone is that along the line of sight.

Column 22 gives the time of flight at each range.

Column 23 gives the slope of descent of the bullets compared with the line of sight. This figure enables a fire controller to calculate whether his fire can be brought to bear on reverse slopes.

Columns 24 and 25 (*see* para 9 *(b)* below).

Columns 4 and 15 to 18 deal with crest clearance and safety, which will be learnt later.

(b) Pages 14 and 15, give the foreshortening effect of a forward slope on the length of the beaten zone, and the lengthening effect of a reverse slope. The gaps in the bottom left-hand corner of the table are caused by the fact that, at those figures, the reverse slope is steeper than the angle of descent of the bullet, with the result that such slopes are " dead ground " when engaged at those ranges.

(c) Page 16 gives the formula to determine the angles of sight and the allowance for moving targets. (Lesson 101).

(d) Page 17. The machine gun is sighted for a horizontal angle of sight, and is therefore sufficiently accurate for all angles of sight between plus 10 degrees and minus 10 degrees.

If the angle of sight exceeds 10 degrees, allowance must be made in accordance with the chart. If it be imagined that a target is being engaged immediately above or below the gun, *ie*, at an angle of sight of 90 degrees, clearly no tangent angle is required on the sight, no matter what the range. At steep angles of sight, therefore, less elevation is required than for a horizontal angle of sight. (*See* example at the foot of the chart).

(e) Pages 18 and 19. This table caters for the possible situation in battle where the supply of Mark VIIIZ ammunition has temporarily failed, but where Mark VII is obtainable for filling into belts. Owing to the differences in trajectory of the two kinds of ammunition, the reading on the tangent sight for Mark VIIIZ is not correct for Mark VII. In column 2 is given the reading to be put on the sights when engaging targets shown in column 1.

VI Graph

8. The commonest uses of the VI graphs are:—

(a) Knowing the range, to determine the distance or height subtended by a certain angle.

(b) Knowing the range, to determine the angle subtended by certain distance or height.

In Fig 19 if G is the gun, and GA the range, then AB is the distance subtended by AGB at the range GA, and A1 B1 is the distance subtended by the angle AGB at that range GA1.

Similarly the angle AGB is said to subtend AB and A1 B1 at the ranges GA and GA1 respectively.

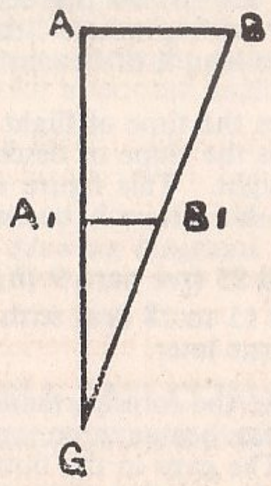


FIG 19

Example:—

Angle AGB equals 4 degs 10 mins.
Range GA equals 3,000 yards.
What is the length of AB?

Following the 10 minute column down until it is opposite 3,000 yards read off the amount subtended by 10 minutes at 3,000 yards, *ie*, 9 yards. Repeat for 4 degrees, *ie*, 209 yards. Add the two figures together, *ie*, 218 yards AB is 218 yards.

9. Climatic influences

(a) The following are the normal conditions for the sighting of small arms:—

Barometric pressure—30 inches (mean sea level).
Temperature—60 degrees Fahrenheit.
Still air.
A horizontal line of sight.

(b) *Barometer and temperature.*—If the barometer falls below 30 inches, less elevation than is normally required for the distance will be necessary, as the atmosphere, being less dense, offers less resistance to the bullet. It should be noted that the barometer will fall one inch for every 1,000 feet above mean sea level. If the barometer rises above 30 inches, more elevation is required, as the air is more dense. The bullet meets with less resistance in hot weather when the temperature is high and the air less dense; and greater resistance in cold weather, when the temperature is low. In the former case, therefore, less elevation is required, and in the latter more.

Allowances for one inch rise or fall of barometer and 10 degrees rise or fall in temperature will be found opposite each range in columns 24 and 25 of pages 2 to 7 of the range table. It should be noted that for a fall in barometer, and in a rise in temperature, the allowance to be made is subtracted and *vice versa.*

(c) *Wind.*—Winds blowing directly along the line of fire from front to rear will affect the elevation, but here again unless the wind is very strong and the range long, the allowance required is small.

Winds blowing directly at right angles to the line of fire will affect direction and have considerable effect on the bullet, particularly at long ranges.

Winds blowing from a direction oblique to the line of fire will affect both direction and elevation.

Although where speed is essential it may be necessary to estimate in taps the lateral allowance to be made for a side wind, reference should be made to the wind table in the range tables when time permits.

Having estimated the strength and direction of the wind, the allowance required may be obtained from the range tables on pages 2 to 7, columns 5 to 13.

An explanation of the use of the wind tables is on page 8 on the range table.

11. Practise the squad in correcting the range to cater for varying climatic conditions at various ranges.

Conclusion

11. Questions from class.
12. Further practice if required.
13. Discuss progress made.
14. Sum up main points.

LESSON 96.—ERRORS IN DIRECTION AND ELEVATION

A INSTRUCTOR'S NOTES

Aim

1. To explain the causes of errors in direction and elevation and to show the means by which these errors are overcome.

Class and instructors

2. One officer instructor and preferably not more than 30 in the class.

Periods

3. One 45-minute period, lecture.

Stores

4. Blackboard and chalk. Class require range tables.

Preparation

5. Write the combined sight rule on the blackboard.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 above).

Errors in elevation

Explain:—

7. Errors in elevation may be caused by:—
   (a) Inaccuracy in determining the range.
   (b) Incorrect allowance for climatic conditions.
   (c) Slight inaccuracies of aim or sighting of the guns.

8. The range may be determined by:—
   (a) *Rangefinder*—the most accurate method.
   (b) *Measurement* on a map of not less scale than 1/25,000. The map must be in good condition and target and gun accurately located.
   (c) *Key ranging*—that is by estimating from ranges taken by either of the above methods. This method is reasonably accurate up to 1,500 yards but beyond that should only be used in emergency.

9. To ensure hitting the target, possible errors in elevation must be allowed for. To this end, the combined sight rule has been evolved. Dependent on the method used for determining the range, this rule gives the number of elevations to be employed at all ranges.

COMBINED SIGHT RULE

Range	Number of elevations
0—1400	1
1450—2000	3
2050—2800	5

10. The fire controller should fire at the target with the range on the sights that he has already determined plus or minus any allowance for wind. Should the rule require 3 elevations, he will then order "**All down 50, Go on**" fire on that elevation and then order "**All up 100, Go on**" He has then fired at the supposed range to the target, the range 50 yards below the target and the range 50 yards above the target.

Should the rule require 5 elevations, he will subsequently order "**All down 150, Go on**" and "**All up 200, Go on**" He has thus, in addition, fired with the ranges 100 yards below and 100 yards above the target.

11. If the target has a difference in range to each end, the mean range will be used for determining the number of elevations required to cover possible errors in elevation.

12. If good observation of fire is obtained, the combined sight rule will not be applied.

Errors in direction

Explain:—

13. Errors in direction may be caused by:—
   (a) Wrong estimation of the strength of side winds.
   (b) Slight inaccuracies of aim.
   (c) Wear in the mounting.

14. As the errors may act in either direction, it will be necessary to engage an additional width on either side of the target. Lateral errors will not be great but the beaten zone is narrow and does not give much help in overcoming them. Guns will initially be laid and fired at the target and, if necessary, tapped and fired to cover the width of the target. Then, to ensure that possible errors are covered, arrangements will be made for guns to fire one tap (15 minutes) outside the edges of the target.

15. Owing to the width of the beaten zone, if good observation of fire is obtained the tap to cover errors in direction may be cut out.

Conclusion

16. Questions to and from the class.

17. Sum up main points.

CHAPTER 17

DIRECT FIRE

INTRODUCTORY NOTES

1. The direct fire unit is the section, because:—

(a) Two guns are required to give the necessary volume at the most usual machine gun ranges.

(b) In the event of the stoppage of one gun, sustained fire can be maintained by the other.

(c) It can easily be concealed and is not too vulnerable.

2. The requirements of fire control necessitate the two guns being under the command of a fire controller, who is supplied with a rangetaker to enable him to determine the range and to observe the fire.

3. In order to avoid casualties, the two guns of a section in action should be as far apart as possible, provided that the section commander is able to control the two guns by voice.

4. At distances beyond 2000 yards, the volume of fire produced by a section cannot always be relied upon to give results proportionate to the expenditure of ammunition, and the fire of two sections may have to be directed onto the same target from their respective positions.

LESSON 97.—FIRE ORDERS, DIRECT

A INSTRUCTOR'S NOTES

Aim

1. To teach the sequence and layout of a direct fire order.

Class and instructors

2. One officer instructor and not more than 30 in the class.

Periods

3. One 45-minute period, lecture.

Stores

4. Blackboard and chalk.

Preparation

5. Write the sequence of a fire order on the blackboard.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 above).

7. State that the following is the procedure for engaging a target by a section:—

(a) The section commander by means of a fire order gives a range and indicates a point of aim on the target for both guns.

(b) Each firer sets his tangent sight at the range ordered, and by tapping the gun and by use of the handwheel, directs the line of sight on to the point ordered. Thus the gun is laid initially both for direction and elevation.

Issuing fire orders

8. Tell the class that fire orders are given in sequence as in para 9 below, and that sequence must not be departed from. Rigid adherence to the sequence will ensure that errors and omissions are detected immediately, and that the gun numbers, knowing what to expect, will act more quickly.

The orders must be given loudly and clearly, the section commander facing towards the guns. He must make up his mind what is the correct order to give before embarking on it. Long and unnecessary pauses, during which he is coming to a decision as to the next part of the order, can result only in inaccuracies and slovenly drill.

THE BEST FIRE ORDER IS THAT WHICH GETS BULLETS ONTO THE TARGET IN THE SHORTEST POSSIBLE TIME.

Sequence

9. Point out the sequence of a fire order:—

Designation.
Range (including wind allowance, if necessary).
Indication of the target.
Method of fire.
Lay.
Side wind allowance.
Rate of fire.
Order to fire.

10. Explain that when giving out the order, pauses should be made as under, until it is seen that the gun numbers are ready for the next part of the order:—

After the range	... ...	To allow time to set the sights.
At various stages during the indication	...	Time must be given for points to be recognized. When degree method of indication is used, a pause must be made to enable the angles to be measured.
After method of fire	...	To enable the guns to be laid.
After wind allowance	...	To allow time to pick up an aiming mark.

Explanation of headings in fire order

11. Explain each heading of the fire order as under:—

(a) Range

(i) Ranges when ordered to the guns will be given to the nearest 50 yards and according to the examples in Lesson 52, para 12.

(ii) For the first target the section commander will usually obtain the range from the rangetaker but, where the situation demands it, he should not hesitate to estimate the range. For subsequent targets, to save time, ranges can be key ranged.

(iii) When the range is ordered to the guns, it will be preceded by the word **"All,"** *eg*, **"All—one two hundred"**

(iv) If the wind is sufficiently high to warrant a correction to elevation, the range will be corrected before being given out.

(b) Indication.—The section commander will indicate the target as laid down in Lesson 66. Reference points and degrees should be used only when they are necessary in order to indicate the target clearly.

(c) Method of fire.—This is dependent on whether the target has width, depth or neither. It may take any of the following forms:—

(i) **"Right and left—two taps "Lay"**
Both guns are laid on the target. When **"Fire"** is ordered, they are fired and tapped TWO TAPS right and left of the target. No. 1 gun starts tapping to the right first and No. 2 gun to the left.

(ii) **"Traversing lay"**
Both guns are laid on the centre of the target. When **"Fire"** is ordered each gun traverses its own half of the target.

(iii) **"Half way up—Right and Left—Two taps "Lay"**
Both guns are laid halfway up the depth of the target. When **"Fire"** is ordered each gun acts as in sub-para 1.

(d) Side wind.—The section commander will calculate the effect of the side wind to the nearest tap (Lesson 95).
It will be ordered to the guns in the following form:—
"Wind—Right (or left) "Taps"
Nos. 1 tap their guns across by the number of taps ordered, pick up an aiming mark and report **"On"**
If the allowance is one degree or more, it should be ordered in degrees.
Nos. 1 by means of a hand angle will pick up an aiming mark.
If no correction is needed, this heading is omitted from the order.

(e) Rates of fire.—If no order is given, normal is implied. If it is desired to fire rapid, the order will be given before the order to fire.

(f) The order to fire.—This will normally be given by the order **"Fire"**

Orders during a shoot

12. State that the following orders may be given out during a shoot:—

(a) **"Stop"** This order is normally given by signal.

(b) Ranging corrections. These may be for:—

(i) *Direction.*—The section commander converts the necessary correction into taps or degrees (if more than three taps) and orders it to one or both guns as required. Nos. 1 note the new aiming point.

Examples—

"All, right two taps"
"No 1 gun, left one degree"

(ii) *Elevation.*—The section commander decides on a new range or the correction required and gives it out.

Examples:—

"All, one four hundred"
"All, down fifty"
"No 1, up fifty"

(c) **"Go on"** This order may be given verbally or by signal.
naked eye to have width, *eg*, a group of bushes or a hedgerow.

Conclusion

13. Questions to and from class.

14. Opportunity can be taken during Lessons 98 to 101 to practise the correct issue of fire orders.

15. Sum up main points.

LESSON 98.—POINT TARGETS

A INSTRUCTOR'S NOTES

Aim

1. To teach the method of engaging a point target by direct fire.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture and demonstration.
One 45-minute period, practice.

Stores

4. Lecture—Blackboard, and chalk, and landscape target.
Practice—Director, gun, tripod, portable blackboard.
Class require range tables.

Preparation

5. Select suitable targets on the landscape target. Prepare blackboard with diagrams as given in Fig 20.

6. Practice—Gun and tripod mounted ten yards to a flank of the director.

B CONDUCT OF LESSON

Approach

7. Give the aim of the lesson (*see* para 1, page 17).

8. Tell the class that a point target is a target that appears to the naked eye to have no width or depth, although in actual fact it must have both.

For example, a target may well be an enemy machine gun detachment covering a width of perhaps five yards. To the gun numbers all that may be visible may be the top of a steel helmet. The width of the beaten zone might not cover the actual width of the target.

Similarly, a point target may be visible to the section commander using his glasses, but presents to the gun numbers no clearly defined point on which to lay. The section commander can indicate the target using the clock ray and degree measurement from an auxiliary reference point, but it is unlikely that the guns will be laid very accurately.

Method of fire

9. State that to ensure that such types of targets are effectively engaged, one extra tap right and left will always be given. This will be in addition to the tap to cover errors in direction.

The rule is, therefore, point targets will always be engaged at all ranges with " RIGHT AND LEFT TWO TAPS."

Lifts

10. Explain that errors in elevation will be overcome by the combined sight rule. Nos. 1 tapping right and left at each elevation.

Illustrate on the blackboard a section engaging a point target at 1200 yards (key ranging). (*See* Fig 20).

Illustration

11. Illustrate the engagement of the following types of targets by a section:—

Point target below 1400 yards.
Point target between 1450 and 2000 yards.

The following examples of fire orders may be of assistance to the instructor:—

Reference points are as shown in Plate 21.
Target " A "—point target—900 yds (rangefinder).
" All, nine hundred.
Right of arc—group of four large trees—left tree.
Right and Left—Two taps. Lay.
Rapid fire."

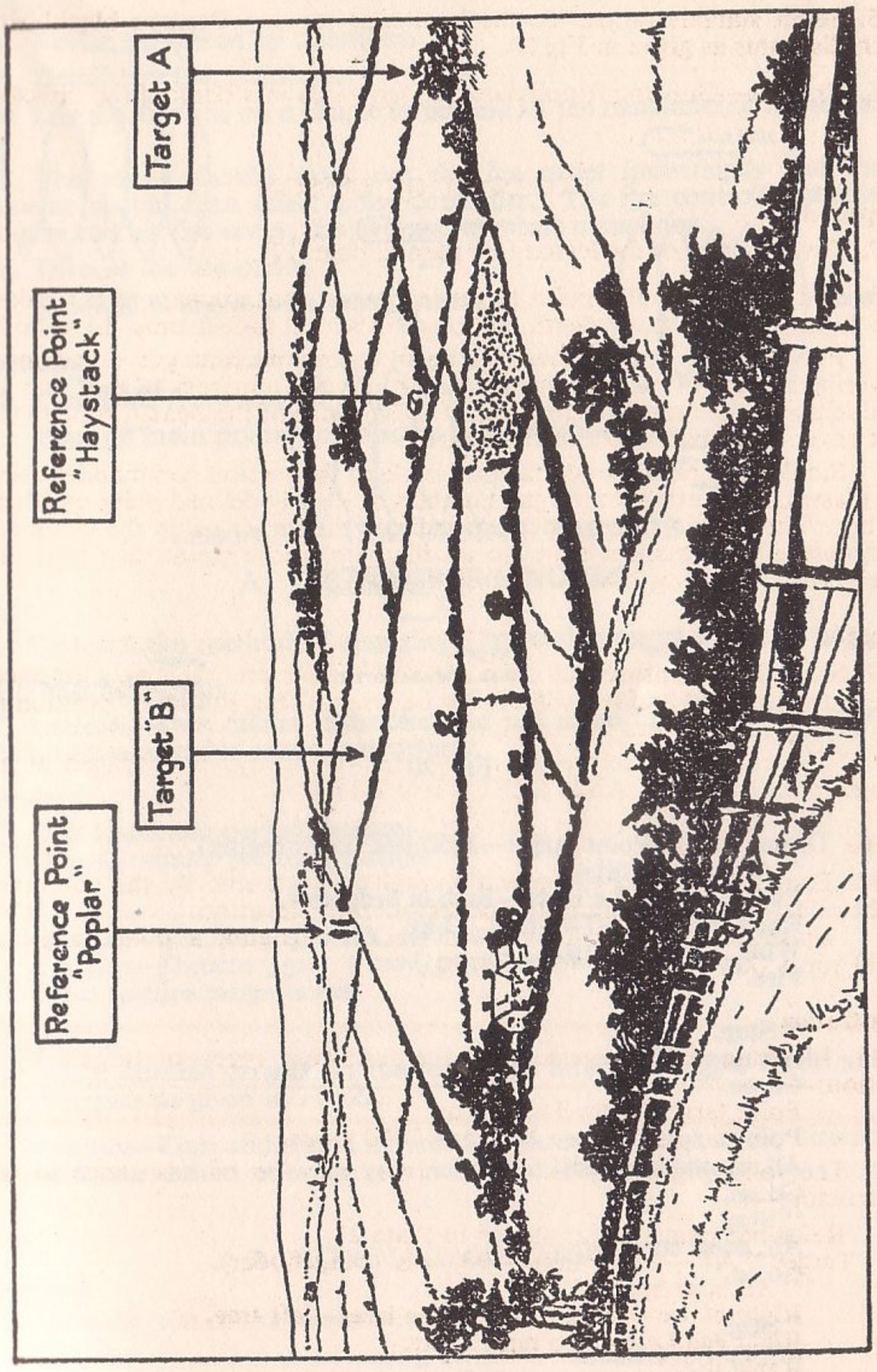


PLATE 21

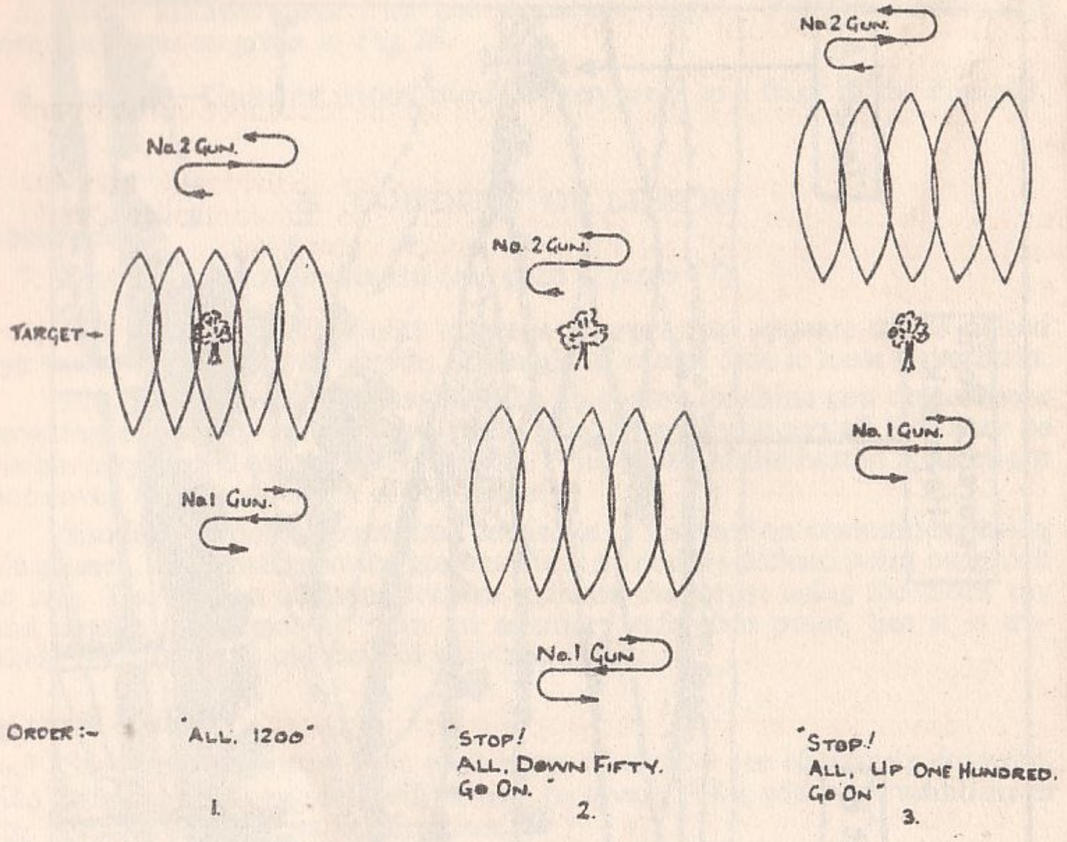


FIG 20

Target " B "—Point target—1650 yds (key ranging).

" All, one six fifty.
Poplar—right 3 o'clock—bush in hedgerow.
Right and Left—Two taps. Lay.
Wind, right one tap.
Fire."

" Stop.
All, down fifty.
Go on."

" Stop.
All, up one hundred.
Go on."
" Stop.
All, down one fifty.
Go on."

" Stop.
All, up two hundred
Go on."

Practice

12. Revise the lesson by questions.

13. Detail two gun numbers.

14. Lay the director on a simple target and let the remainder of the squad view.

15. The squad should work out the fire order individually and the instructor should then select a fire controller. The fire controller should then give out his fire order, the two gun numbers complying.

16. Discuss the fire order.

17. Proceed as above with other targets.

Conclusion

18. Questions from squad.

19. Sum up main points and discuss progress made.

LESSON 99.—TRAVERSING TARGETS

A INSTRUCTOR'S NOTES

Aim

1. To teach the method of engaging a traversing target by direct fire.

Class and instructors

2. Lecture.—One officer instructor and not more than 30 in the class. Practise squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

4. Lecture—Blackboard, chalk, two guns.
Practice—Director, gun, tripod, portable blackboard.
Class require range tables.

Preparation

5. Select suitable targets on the landscape target. Prepare blackboard with diagrams as given in Fig 22.

6. Practice—Gun and tripod mounted 10 yards to a flank of the director. The instructor should select targets before the lesson begins.

B CONDUCT OF LESSON

Approach

7. Give the aim of the lesson (*see* para 1).

8. Tell the class that a traversing target is a target that appears to the naked eye to have width, *eg*, a group of bushes, or a hedgerow.

A traversing target may well have a different angle of sight to each end, *eg*, a hedgerow running up the side of a hill. But so long as it has no greater difference than 50 yards in the range to each end, it is a traversing target.

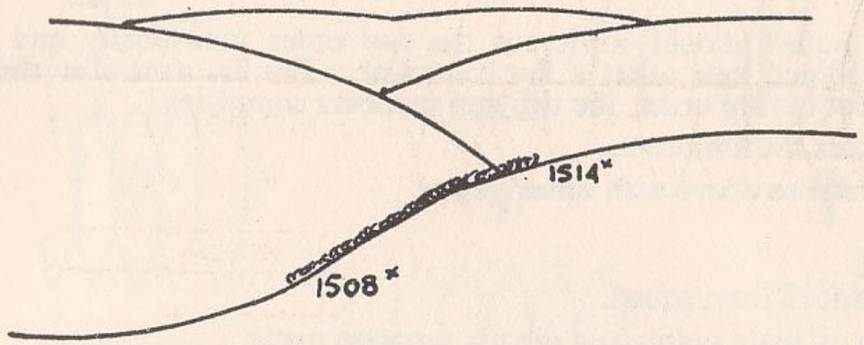


FIG 21

9. State that a section should not engage a target more than 100 yards wide. If a target exceeds this width, it must be split up and engaged as separate targets.

Method of fire

10. Explain that the method of engaging a traversing target is as follows:—

> On the order "**Traversing lay**", both guns are laid in the centre of the target. On the order "**Fire**" both guns fire at the centre.

Each gun is then tapped one tap outwards, the line of sight relayed and fired again. This process is continued until the guns reach the end of the target. They are then tapped one tap outside of the ends to cover errors in direction and then traversed back to the centre. To ensure the overlap of the beaten zones at the centre, each gun is tapped one tap over the centre (*see* Fig 22). The line of sight is re-aligned onto the target after each tap.

Lifts

11. Tell the class that errors in elevation will be overcome by the combined sight rule, gun numbers traversing their own half of the target at each elevation.

Obscuration

12. State that when engaging a target that is likely to become obscured, the section commander will order Nos. 1 to lay their guns a quarter way in from each end of the target, and order "**Pick up aiming mark**" The section commander will measure the width of the target with his binoculars, divide it by four and bring it to the nearest tap, adding one tap for overlap. Guns can then engage each half of the target by tapping right and left the number of taps ordered.

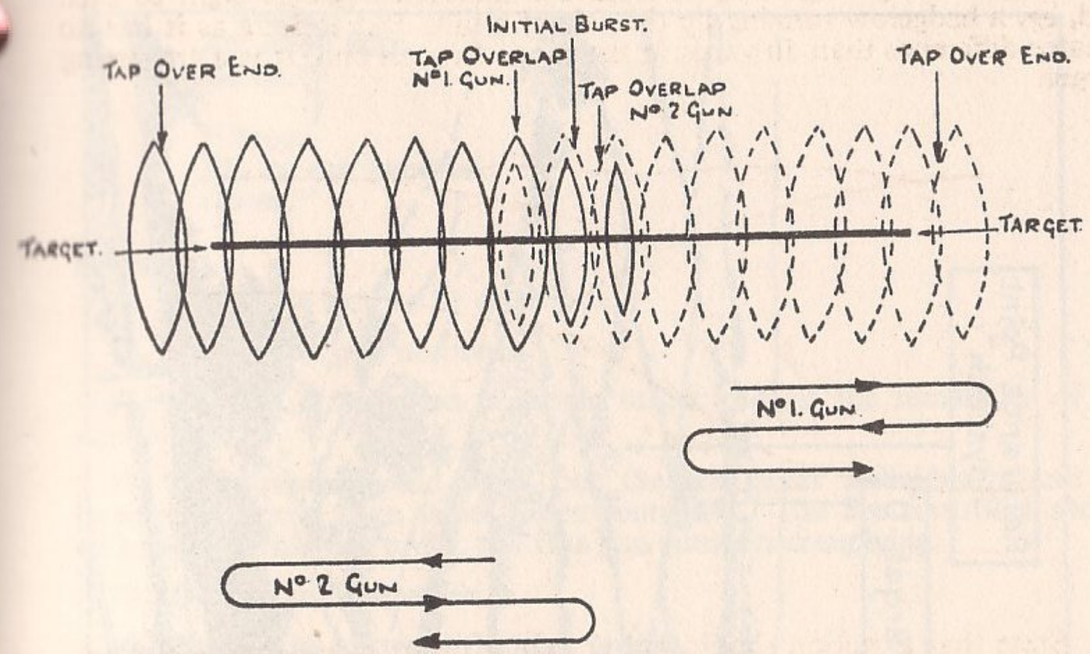


FIG 22

Example:—

Target = 2°40′ wide.
2° 40′ ÷ 4 = 40′ = 3 taps (to the nearest).
Add one tap for overlap.
Order "**Right and left 4 taps.**"

Demonstration

13. Demonstrate the engagement of the following types of targets, by a section:—

Traversing target at all ranges.

Traversing target with a different angle of sight to each end.

The following examples of fire orders may be of assistance to the instructor:—

Reference points are as shown in Plate 22.

Target "C"—traversing target—900 yards (rangefinder).

"All, nine hundred.
Poplar,—6 o'clock—right end of house—left limit.
Right 3 o'clock 2 degrees—bush—right limit.
Traversing lay.
Fire."

Target "D" 1350 yards (estimated)

"All, one three fifty.
Haystack—left 11 o'clock—group of bushes at corner of field.
Traversing lay.
Fire."

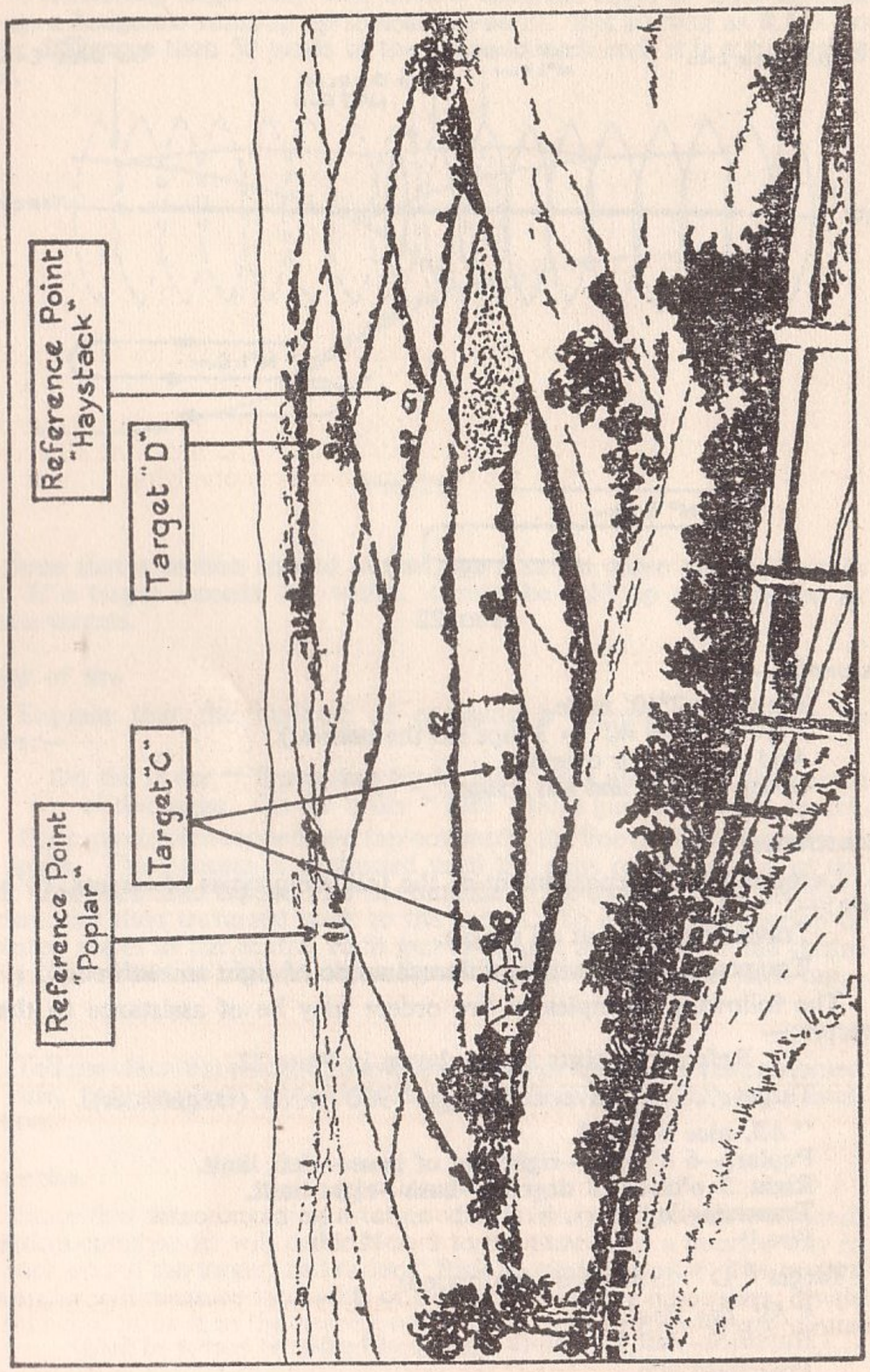


PLATE 22

" Stop.
All, down fifty.
Go on."

" Stop.
All, up one hundred.
Go on."

Practice

14. Revise the lecture by questions.

15. Detail two gun numbers.

16. Lay the director on a simple target and let the remainder of the squad view.

17. The squad should work out the fire order individually and the instructor should then select a fire controller. The fire controller should then give out his fire order, the two gun numbers complying.

18. Discuss the fire order.

19. Proceed as above with other targets.

Conclusion

20. Questions from squad.

21. Sum up main points and discuss progress made.

LESSON 100.—DEPTH TARGETS

A INSTRUCTOR'S NOTES

Aim

1. To teach the method of engaging a depth target by direct fire.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture and demonstration.
One 45-minute period, practice.

Stores

4. Lecture—Blackboard, chalk, landscape target.
Practice—Directors, gun, tripod, portable blackboard.
Class require range tables.

Preparation

5. Select suitable targets on the landscape target. Prepare blackboard with diagrams given in Figs 23 and 24.

6. Practice—Gun and tripod mounted ten yards to a flank of the director. The instructor should select targets before the lesson begins.

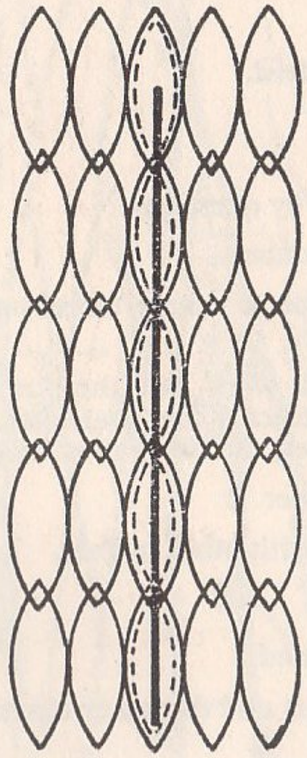


FIG 23

B CONDUCT OF LESSON

Approach

7. Give the aim of the lesson (*see* para 1 above).

8. Tell the class that a depth target is a target that has a difference in the range to each end of more than 50 yards. A section should not engage a target with a greater depth than 200 yards. If a target exceeds this depth, it must be split up and be engaged as separate targets.

9. State that a depth target can take two forms, it can either have no appreciable width or it can have width. In other words, as regards direction, it can either appear to be a point target or a traversing target. For direction, then, a depth target should be treated as laid down in Lesson 98 and 99.

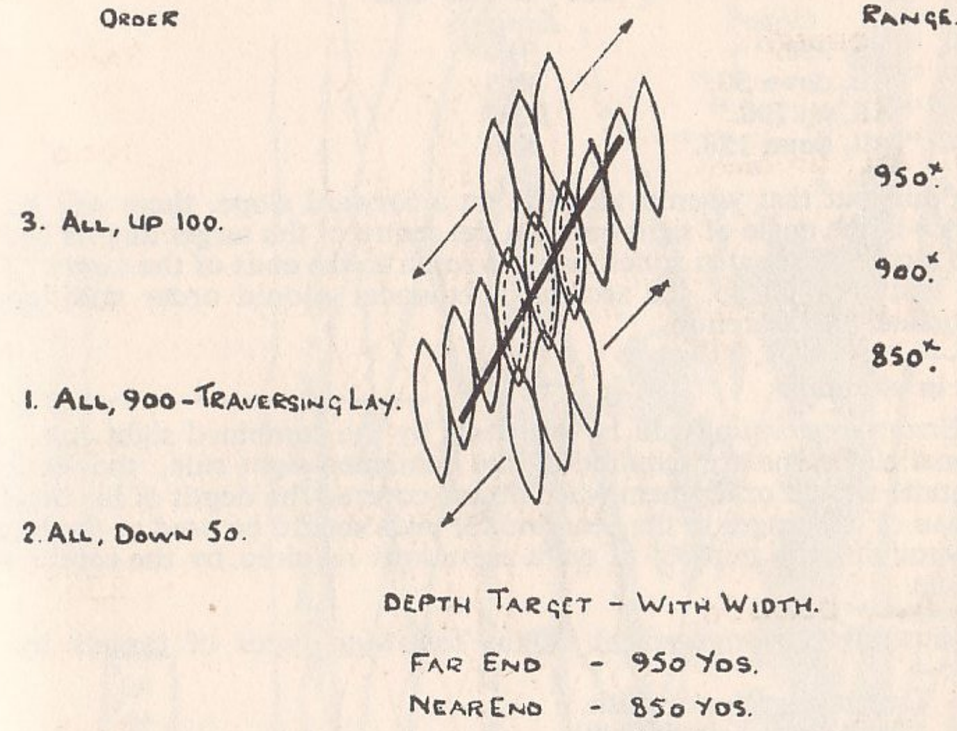


FIG 24.

Method of engaging

10. Explain that the method of engaging a depth target is as follows:—

The section commander will indicate the limits of the target and order "**Halfway up. Right and Left. Two taps. Lay.**"

If the target is more than 30 minutes wide the order will be "**Traversing Lay,**" as Right and Left two taps will not cover the width of the target and allow for errors in direction.

The section commander will then apply sufficient lifts in the form "**All down fifty—All up one hundred etc.**" to cover the depth of the target, the guns being tapped or traversed at each elevation.

On a target with no appreciable width, the line of sight will be maintained on the centre of the target throughout. On a target with width, the line of sight will be re-aligned as the guns traverse across their own half of the target.

11. Illustrate the engagement of the two types of target on the blackboard. (*See* Figs 23 and 24).

12. State that if the difference in range between the ends of a target is 150 yards, then the range 50 yards short of the far end should be used as the opening elevation. In this case, to cover the depth of the target, two elevations below the opening elevation will be required and only one above.

Example:—

Target ... { 1000 yds far end.
850 yds near end.

Order	*Range*
" All, 950."	950
" All, down 50."	900
" All, up 100."	1000
" All, down 150."	850

13. Point out that when a target is on a forward slope, there will be a difference in the angle of sight between the centre of the target and its ends. In such a case, the beaten zones may not reach to the ends of the target. To ensure that they do so, the section commander should order additional elevations at his discretion.

Errors in elevation

14. Errors in elevation will be overcome by the combined sight rule. If additional elevations are required by the combined sight rule, the section commander should order them when he has covered the depth of his target. The mean of the ranges to the near and far ends should be used as the basis for determining the number of extra elevations required by the combined sight rule.

15. Illustrate the engagement of the following types of targets by a section:—

Depth target—no width.
Depth target—with width.
Depth target—150 yards difference in range to each end.

The following examples of fire orders may be of assistance to the instructor:—

Reference points are as shown in Plate 23.

Target " E."—Depth target—no width.
Far end. 897 yds.
Near end. 708 yds.

" All, eight hundred.
Poplar, right 4 o'clock, T-shaped junction of hedgerows—Far end.
6 o'clock, end of hedgerow—Near end.
Halfway up, right and left—two taps. Lay.
Wind, left one tap.
Fire."

" Stop.
All, down fifty.
Go on."

" Stop.
All, up one hundred.
Go on."

" Stop.
All, down one fifty.
Go on."

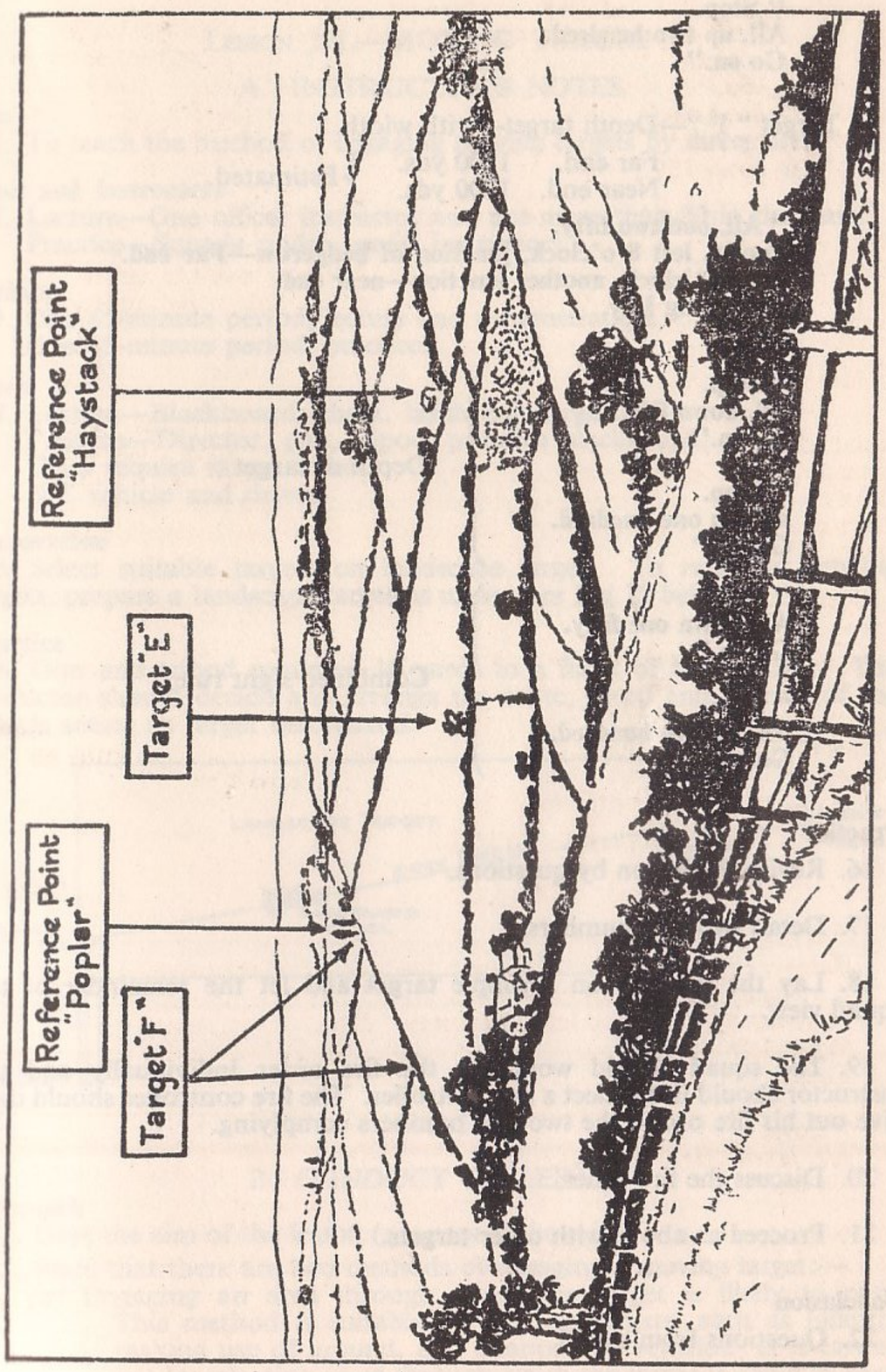


PLATE 23

" Stop.
All, up two hundred.
Go on."

Target " F "—Depth target—with width.

Far end. 1300 yds. } Estimated.
Near end. 1200 yds. }

" All, one two fifty.
Poplar, left 8 o'clock, junction of hedgerow—Far end.
Left 8 o'clock, another junction—near end.
Traversing Lay.
Fire."

" Stop.
All, down fifty.
Go on."

" Stop.
All, up one hundred.
Go on."

} Depth of target.

" Stop.
All, down one fifty.
Go on."

" Stop.
All, up two hundred.
Go on."

} Combined sight rule.

Practice

16. Revise the lesson by questions.

17. Detail two gun numbers.

18. Lay the director on a simple target and let the remainder of the squad view.

19. The squad should work out the fire order individually and the instructor should then select a fire controller. The fire controller should then give out his fire order, the two gun numbers complying.

20. Discuss the fire order.

21. Proceed as above with other targets.

Conclusion

22. Questions from squad.

23. Sum up main points and discuss progress made.

Lesson 101.—MOVING TARGET

A INSTRUCTOR'S NOTES

Aim

1. To teach the method of engaging moving targets by direct fire.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture and demonstration.
One 45-minute period, practice.

Stores

4. Lecture—Blackboard, chalk, landscape target.
Practice—Director, gun, tripod, portable blackboard.
Class require range tables.
MT vehicle and driver.

Preparation

5. Select suitable targets on landscape target. To represent moving targets, prepare a landscape target as under (*see* Fig 25 below).

Practice

6. Gun and tripod mounted 10 yards to a flank of the director. The instructor should decide and arrange the route, speed and timings of the vehicle acting as target beforehand.

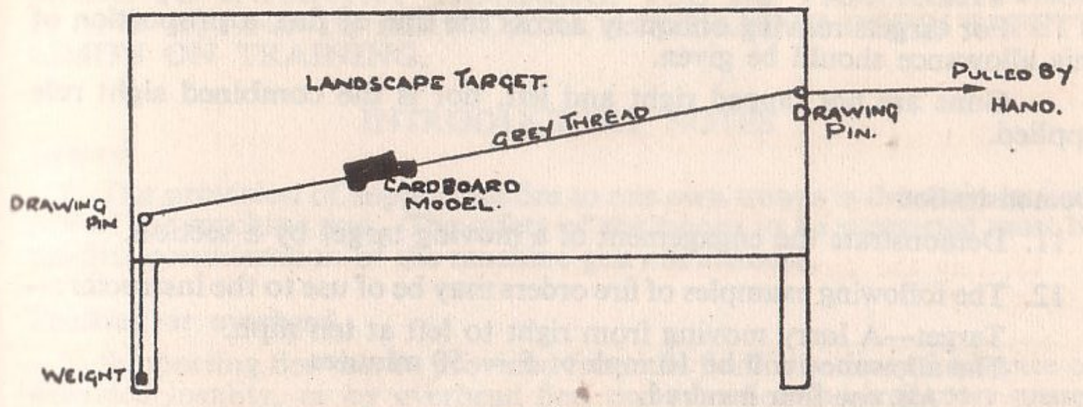


Fig 25

B CONDUCT OF LESSON

Approach

7. Give the aim of the lesson (*see* para 1 above.)

8. State that there are two methods of engaging a moving target:—

(a) Engaging an area through which the target is likely to pass. This method is suitable for fleeting targets, such as infantry making use of ground, and unarmoured vehicles. It is carried out by selecting areas through which the target is likely to pass, and giving an anticipatory fire order based on the estimation of the speed and direction of the target.

(b) *Swinging traverse.*—This is a suitable method of engaging moving targets at close range, when other methods would be too slow, or it may be used when the target is particularly suited to this method of engagement, *eg*, a line of infantry.

Fire control

9. Tell the class that:—

(a) Fire orders must be short and simple, otherwise the opportunity of engaging the target may be lost.

(b) The section commander will maintain control until, owing to the closeness of the range or other factors, greater fire effect may be expected from gun control. He must change to gun control before unit fire control breaks down.

(c) When engaging a moving target, whether by a section or gun control, attention must be directed continually to:—

(i) The changing line of sight, both horizontally and vertically.

(ii) Alterations in range.

(iii) The amount which the fire has to be directed in front of the target. This depends upon the speed and direction of the target.

10. Explain that the appropriate angle in minutes through which the target will travel during the time of flight of the bullets can be determined by multiplying the target speed in miles per hour by the factor 5 at all ranges.

For targets moving obliquely across the line of fire, a proportion of this allowance should be given.

Guns are not tapped right and left, nor is the combined sight rule applied.

Demonstration

11. Demonstrate the engagement of a moving target by a section.

12. The following examples of fire orders may be of use to the instructor:—

Target—A lorry moving from right to left at ten mph.
The allowance will be 10 mph × 5 = 50 minutes.

" All, one four hundred.
Left of arc—house—right 3 o'clock—hedge junction.
Lay.
Wind, left one tap.
Await my order."

The section commander picks up a point 50 minutes to the right of the hedge junction. When the target reaches this point, he gives the order to fire.

Target—Enemy advancing across field, range 400 yards.

" All, battle sight.
Enemy advancing across field.
Swinging traverse.
Fire."

Practice

13. Revise the lesson by questions.

14. Detail two gun numbers.

15. Indicate the arc of fire.

16. Members of the squad should act as section commander and issue fire orders to engage the target as it appears.

17. Discuss the fire order.

18. Proceed as above when the target moves again.

Conclusion

19. Questions from squad.

20. Sum up main points and discuss progress made.

CHAPTER 18

FLANKING AND OVERHEAD FIRE

ALL SAFETY ALLOWANCES GIVEN IN THIS CHAPTER ARE THOSE ACCEPTABLE IN WAR. FOR SAFETY ALLOWANCES DURING PEACETIME TRAINING, REFERENCE SHOULD BE MADE TO INFANTRY TRAINING, VOL III, PAMPHLETS Nos. 31 AND 33, AND TO PERIODICAL ACIs LAYING DOWN SAFETY LIMITS ON TRAINING.

INTRODUCTORY NOTES

General

1. The provision of supporting fire to our own troops is the main tactical role of the machine gun. The safety of the troops to be supported must be the first consideration of the machine gun commander.

Flanking or overhead

2. Supporting fire can be provided from the flank of a line of advance or defended locality, or by overhead fire, that is, when the trajectory passes over the heads of our own troops. Where possible, flanking fire positions should be sought; not only because of the greater fire effect usually obtained from the beaten zone in enfilade, but also because fire from a flank can be put down with safety considerably closer to the troops being supported than can overhead fire. Before the occupation of a position for the purpose of overhead fire, it is necessary to determine that such fire will be safe to our own troops. This increases the time required for the guns to be brought into action.

Position of own troops

3. In order that the safety of the troops may be ensured, it is essential that their position or movements should be observed by or known to the fire

controller. In defence, such observation or knowledge should not present any serious difficulty. In attack, the possibility of observing the movements of our own troops will depend on various factors, *eg*, the nature of the ground (whether open, close, flat or hilly) and obstructions to the field of view, (bad visibility, smoke screen, etc.). Since such observation can hardly be assured, it is evident that considerable caution will have to be exercised.

4. Apart from the above considerations, the machine gun, by reason of its stable mounting and the close grouping of its fire, is well suited to carry out flanking or overhead fire with safety to our own troops.

Rules of safety

5. Flanking and overhead fire are governed by definite rules, which are contained in the following Lessons. These rules take into account unarmoured troops in the open. If our own troops are dug in, commonsense will indicate to what extent these rules can be relaxed. For instance, it may be safe to fire just over the top of a trench 200 yards in front of the guns. But at longer ranges, the risk of dropping bullets at a steep angle of descent into our weapon pits must be considered. Tanks are immune from machine gun fire, and fire may be put down close ahead of, or even among, friendly tanks.

6. On occasions it may be unsafe to engage a target if the fire control rules are complied with. It may, however, be possible to fire on the target by modifying the fire control rules, by reducing either the number of taps or the number of elevations.

LESSON 102.—FLANKING FIRE

A INSTRUCTOR'S NOTES

Aim

1. To teach the rules of flanking safety.

2. To teach how to give the maximum possible support with safety to our own troops when advancing in the attack.

Class and instructors

3. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

4. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

5. Lecture—Blackboard and chalk.
Practice—Two directors and portable blackboard.
Class require range tables and binoculars.

Preparation

6. Lecture—Draw the diagrams given in Fig 26 on the blackboard.
Practice—The instructor should select targets and positions of own troops and prepare problems before the lesson begins.

B CONDUCT OF LESSON

Approach

7. Give the aim of the lesson (*see* para 1 and 2 above).

8. State that flanking fire may be of two types:—
(a) Engaging a target towards which our own troops are advancing until it is no longer safe to fire.
(b) Laying a belt of protective fire as close in front of an infantry locality as is consistent with safety. This is dealt with in Lesson 113.

Rules

9. Tell the class that flanking fire is covered by six main rules which are stated and explained below.

10. RULE ONE.—THE POSITION OF OWN TROOPS MUST BE KNOWN OR THEY MUST BE WORKING TO A TIMED PROGRAMME.

This entails the observation of our own troops during the whole time that the guns are firing or the application of a timed programme based on a rate of advance which must not be exceeded by the infantry units concerned.

11. RULE TWO.—BARRELS MUST NOT POINT NOR BULLETS FALL WITHIN THREE DEGREES OF OWN TROOPS. (*See* Fig 26 below).

The lateral allowance of three degrees covers:—
(a) Minor inaccuracies in aiming, tapping and the estimation of the strength of side winds.
(b) Movement of the tripod settling in during firing.
(c) Half the width of the beaten zone.

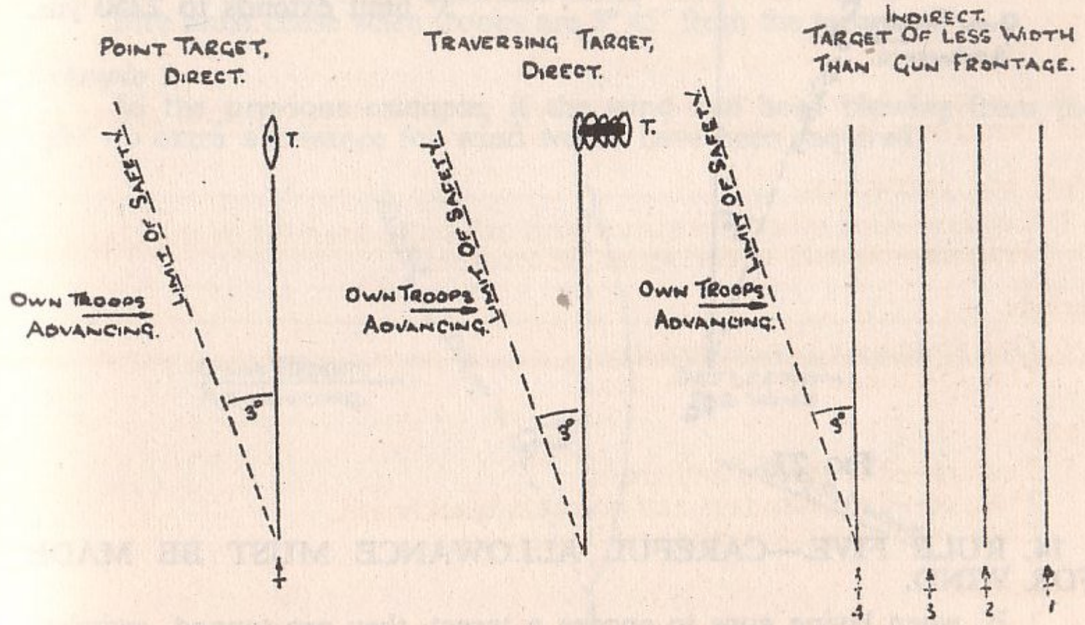


FIG 26

When engaging a target, the allowance of three degrees must be measured from the edge of the target nearest to own troops. The only exception to this rule is in indirect fire, when engaging a target of less width than the gun frontage, the allowance is measured from the point on which the line of fire of the gun nearest to own troops will fall.

Fire must cease when own troops reach the three degree limit of safety.

12. RULE THREE.—GUNS MUST NOT BE TAPPED WITHIN THE THREE DEGREE LIMIT.

This rule implies that the angle through which guns are tapped outside the edge of the target must be added to the basic three degree allowance. The allowance when engaging targets with width by direct fire and targets of equal or less width than the gun frontage by indirect fire is 3°15′. When engaging targets of greater width than the gun frontage by indirect fire the allowance will be 3° 15′, 3° 30′, 3° 45′ or 4° depending on the number of taps required to cover the width of the target. The allowance when engaging point targets by direct fire will be 3° 30′.

13. RULE FOUR.—THE THREE-DEGREE LIMIT EXTENDS TO A POINT 400 YARDS BEYOND THE CENTRE OF THE HIGHEST BEATEN ZONE AT RANGES UP TO 2300 YARDS AND TO A POINT 500 YARDS BEYOND THE CENTRE OF THE HIGHEST BEATEN ZONE AT RANGES ABOVE 2300 YARDS.

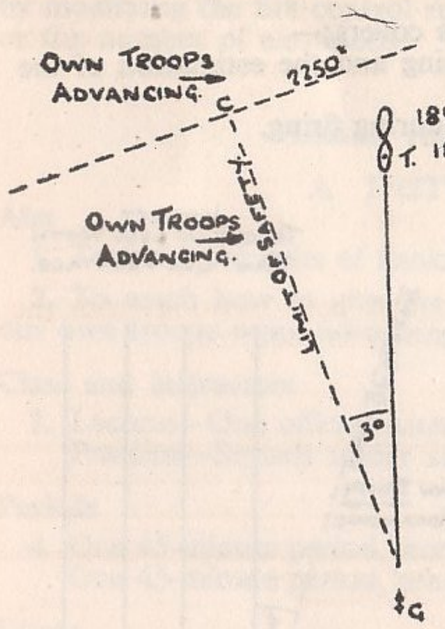


FIG 27

Example

Target—1800 yds (R/F).

Highest elevation—1850 yds.

3° limit extends to 2250 yds.

14. RULE FIVE.—CAREFUL ALLOWANCE MUST BE MADE FOR WIND.

If, when laying guns to engage a target, they are tapped, switched or elevated towards our own troops, the amount that they are tapped,

switched or elevated must be added to the safety allowance (*see* examples below).

Example 1

Guns are engaging a point target with own troops approaching from the left. A wind is blowing from 8 o'clock at 10 mph.

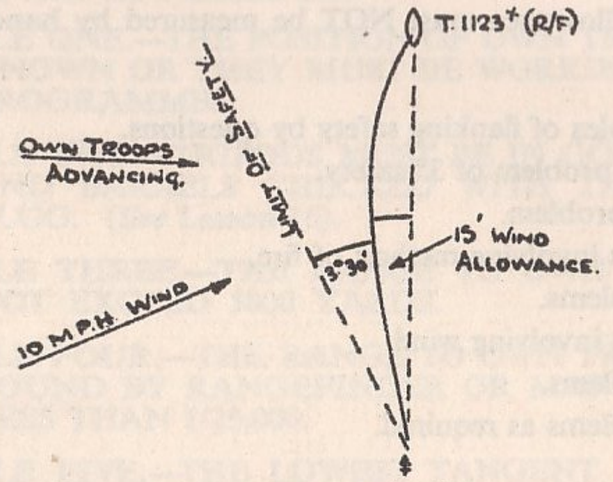


FIG 28

To hit the target, the gun must be tapped to the left one tap (8 o'clock wind at 10 mph requires 13 minutes allowance). This will bring it closer to our own troops. The safety allowance must therefore be:—

Basic angle	...	...	3°
Method of fire	...	...	30′
Wind allowance	...	...	15′
Total allowance	...	...	3° 45′

Fire must cease when troops are 3° 45′ from the target.

Example 2

In the previous example, if the wind had been blowing from the right no extra allowance for wind would have been required.

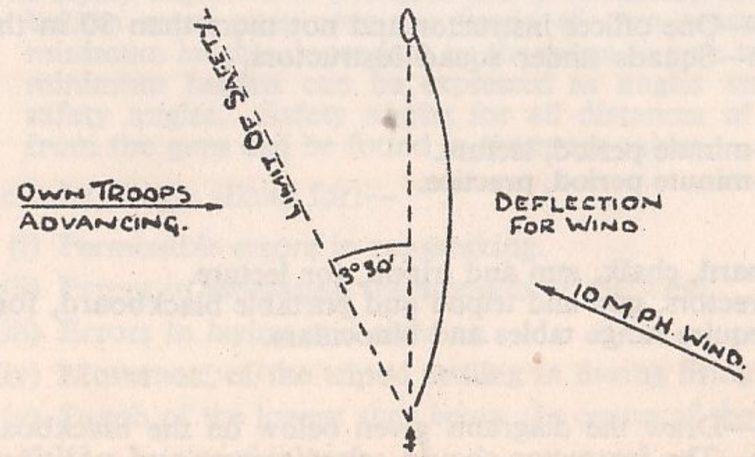


FIG 29

To hit the target, the gun would have to be tapped to the right and away from our own troops. There would be therefore no necessity for increasing the allowance of 3° 30′.

15. RULE SIX.—THE SAFETY ALLOWANCE MUST BE MEASURED BY ACCURATE MEANS.

The safety allowance must NOT be measured by hand angles.

Practice

16. Revise the rules of flanking safety by questions.
17. Set a simple problem of 3° safety.
18. Discuss the problem.
19. Set problems involving method of fire.
20. Discuss problems.
21. Set problems involving wind.
22. Discuss problems.
23. Further problems as required.

Conclusion

24. Questions to and from the class.
25. Sum up main points.

LESSON 103.—OVERHEAD FIRE—DIRECT

A INSTRUCTOR'S NOTES

Aim

1. To teach the rules of overhead safety.

2. To teach how to give with safety the maximum possible support by overhead fire to our own troops advancing in the attack.

Class and instructors

3. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

4. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

5. Blackboard, chalk, gun and tripod, for lecture.
Two directors, gun and tripod and portable blackboard, for practice.
Class require range tables and binoculars.

Preparation

6. Lecture—Draw the diagrams given below on the blackboard.
Practice—The instructor should select targets and positions of own troops and prepare problems.

B CONDUCT OF LESSON

Approach

7. Give the aim of the lesson (*see* para 1 and 2 above).

Rules

8. State the rules for overhead fire:—

(a) RULE ONE.—THE POSITION OF OWN TROOPS MUST BE KNOWN OR THEY MUST BE WORKING TO A TIMED PROGRAMME.

(b) RULE TWO.—TRIPODS MUST BE IN GOOD CONDITION AND BARRELS CHECKED WITH THE .306 GAUGE PLUG. (*See* Lesson 16).

(c) RULE THREE.—THE RANGE TO OWN TROOPS MUST NOT EXCEED 3800 YARDS.

(d) RULE FOUR.—THE RANGE TO OWN TROOPS MUST BE FOUND BY RANGEFINDER OR MAP OF SCALE NOT LESS THAN 1/25,000.

(e) RULE FIVE.—THE LOWEST TANGENT ANGLE TO ENGAGE THE TARGET MUST BE EQUAL TO OR GREATER THAN THE SAFETY ANGLE TO OWN TROOPS PLUS OR MINUS THE GROUND ANGLE.

(f) RULE SIX.—CAREFUL ALLOWANCE MUST BE MADE FOR WIND.

(g) RULE SEVEN.—THE GROUND ANGLE MUST BE MEASURED BY BINOCULARS, DIAL SIGHT OR OTHER ACCURATE MEANS.

Theory

9. Explain:—

(a) The safety angle.—For overhead fire to be carried out with safety, bullets must pass over the heads of own troops at certain minimum heights dependent on the range to own troops. These minimum heights can be expressed as angles and are called safety angles. Safety angles for all distances of own troops from the guns can be found in the range tables.

The safety angle allows for:—

(i) Permissible errors in rangetaking.
(ii) Errors in estimating the strength of the wind.
(iii) Errors in laying and sighting.
(iv) Movement of the tripod settling in during firing.
(v) Depth of the lowest shot below the centre of the cone of fire.
(vi) The height of a lorry.

(b) The ground angle.—The ground angle is the angle between the line of sight to own troops and the line of sight to the target (*see* Fig 30 below).

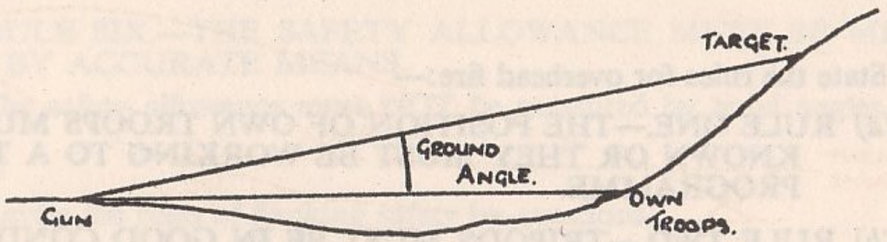


FIG 30

The greater the ground angle, the closer can fire be laid to own troops. This is clearly shown in Fig 31 below.

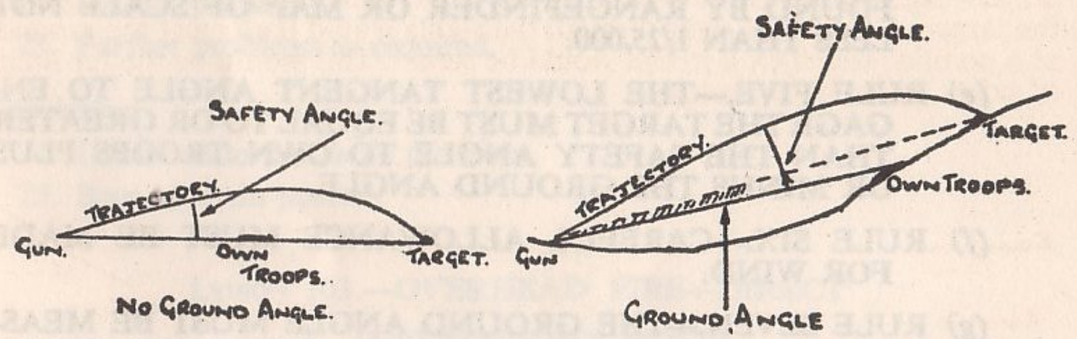


FIG 31

(c) Near and far limits of safety.—When troops are advancing through the gun position to the target, under overhead fire, there must be a point after they have passed the gun position at which they are safe and a point nearer the target at which they again become unsafe. These points are called the near and far limits of safety (*see* Fig 32 below).

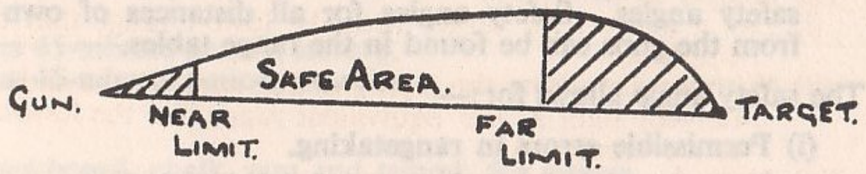


FIG 32

(d) The equivalent range.—The safety angle, which is in effect the angle between the line of sight to own troops and the trajectory giving minimum safety to own troops, is a form of tangent angle. Like a tangent angle, it can be expressed as a range.

This is called the equivalent range. (*see* Fig 33 below).

Equivalent ranges for all distances of own troops from the guns are given in the range tables.

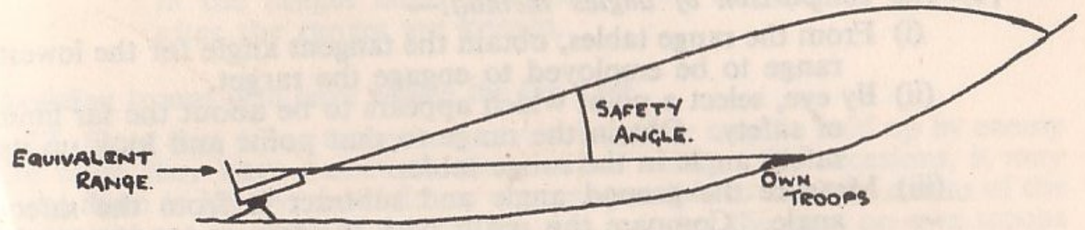


FIG 33

If a gun was laid on our own troops with the equivalent range on the tangent sight, the bullets would pass over their heads with the minimum clearance required by the safety angle. Conversely, if a gun was laid on a target with the range to the target on the tangent sight, the slide on the tangent sight could be moved up to the equivalent range for the range to the target. The line of sight through the sights would then meet the ground at a point at which own troops would be safe. This would be the far limit of safety. (*See* Fig 34 below).

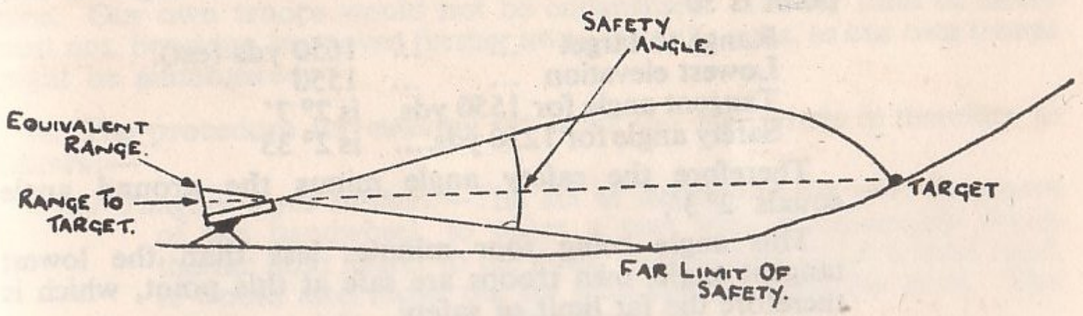


FIG 34

Procedure

10. Describe how to determine the far limit of safety:—

The fire controller can employ either of the following methods:—

(a) The tangent sight method:—

(i) Lay a gun on the target with the lowest range that may be employed.

(ii) Without disturbing the laying of the gun, set the slide on the tangent sight at the equivalent range for the lowest range to be employed.

(iii) Note the point where the new line of sight meets the ground. Select a clearly defined object at that point or as near as possible on the gun position side of it. That is the far limit of safety and fire must cease when own troops reach that limit.

(iv) Move the sight back and check that the laying of the gun has not been disturbed.

The tangent sight method is the simpler and should be employed when the section commander has access to one of his guns. This method cannot be used on flat ground, when the target and far limit are on the same line of sight.

(b) The comparison of angles method:—

(i) From the range tables, obtain the tangent angle for the lowest range to be employed to engage the target.

(ii) By eye, select a point which appears to be about the far limit of safety. Obtain the range to that point and look up its safety angle in the range tables.

(iii) Measure the ground angle and subtract it from the safety angle. Compare the result with the lowest tangent angle to be used. If it is equal to or slightly less than the lowest tangent angle, then you have found the far limit of safety.

(iv) If it is greater than the lowest tangent angle, another point should be selected nearer the gun line and the process repeated until the far limit is found.

The comparison of angles method can be used on all occasions on which overhead fire is to be employed.

Example:—

The point selected as the probable far limit of safety is at a range of 1215 yards, and the ground angle to that point is 30′.

Range to target	1650 yds (est).
Lowest elevation	1550
Tangent angle for 1550 yds.	is 2° 7′
Safety angle for 1250 yds....	is 2° 33′

Therefore the safety angle minus the ground angle equals 2° 3′.

This angle being four minutes less than the lowest tangent angle, own troops are safe at this point, which is therefore the far limit of safety.

11. To determine the near limit of safety the procedure used is the same as for the far limit.

Example:—

The point selected as the probable near limit was 50 yds from the gun position, and the ground angle to that point was 1° 15′.

Range to target	1650 yds. (est).
Lowest elevation	1550 yds.
Tangent angle for 1550 yds.	2° 7′
Safety angle for 50 yds. ...	3° 17′
Ground angle for the point at 50 yds.	1° 15′

Therefore the safety angle minus the ground angle equals 2° 2′ and this being five minutes less than the lowest tangent angle, own troops are safe, and the near limit of safety is therefore 50 yds in front of the guns.

NOTE.—If the ground is flat, no ground angles will come into the problem, and the overhead problem is consequently determined by a straightforward comparison of tangent and safety angles in the ranges table, the position on the ground being found after the ranges are known.

Assisting troops who have passed the far limit

12. State that when troops are advancing, they may be held up by enemy fire when they have passed the far limit of safety. On occasions, it may assist them to lay overhead fire as close as possible to them by means of the equivalent range. The procedure for this is to lay the guns on own troops with the equivalent range for the range to own troops on the tangent sight.

Head and rear winds

13. When engaging a target by overhead fire, a rear wind would tend to blow the bullets over the target. Consequently, the elevation on the guns must be lowered to hit the target. This might bring the lowest tangent angle to be employed lower than the safety angle to own troops, and thus endanger them if the wind suddenly dropped. Arrangements would therefore have to be made to bring the far limit of safety nearer to the guns.

A head wind would have to be offset by raising the elevation on the guns. Our own troops would not be endangered. The far limit of safety must not, however, be moved further away from the guns, as our own troops might be endangered.

14. The procedure for catering for head and rear winds is therefore as follows:—

(a) Tangent sight method.—The act of depressing the gun, by means of the handwheel, to offset a rear wind *automatically* brings the far limit nearer to the guns. When catering for a head wind, it would also move the far limit further from the guns. This must not take place. Therefore,

Rear wind—Use the equivalent range for the lowest range to be employed *after wind correction.*

Head wind—Use the equivalent range for the lowest range to be employed. *Do not correct for wind until after the far limit has been selected.*

(b) Comparison of angles method.—As the calculations to determine the far limit are carried out by the fire controller mathematically, and not manually at the gun, the allowance for a rear wind must be made by the fire controller himself in determining the far limit of safety. Therefore,

Rear wind—Compare the lowest tangent angle to be employed after wind correction with the safety angle plus or minus the ground angle.

Head wind—Compare the lowest tangent angle to be employed with safety angle plus or minus the ground angle. Do not make any allowance for wind when determining the far limit of safety.

Practice

15. Revise the rules of overhead safety.

16. Explain and demonstrate the method of obtaining the far limit of safety by the tangent sight method.

17. Practise the class.

18. Revise the method of obtaining the far limit of safety by the comparison of angles method.

19. Practise the class in problems.

20. Revise the method of obtaining the near limit of safety.

21. Practice the class in problems.

22. Practice the class in all types of overhead fire problems, including wind.

Conclusion

23. Questions to and from the class.

24. Sum up main points.

LESSON 104.—OVERHEAD FIRE—INDIRECT

A INSTRUCTOR'S NOTES

Aim

1. To teach the method of giving overhead fire from an indirect fire position.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.
This lesson should be taught after Chapter 19.

Stores

4. Lecture—Blackboard and chalk.
Practice—Two directors and portable blackboard.
Class require range tables.

Preparation

5. Practice—The instructor should select targets and positions of own troops and prepare problems before the lesson begins.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 above).

Rules

7. State that the rules for overhead fire—direct apply equally to indirect fire.

Far limit

8. Tell the class that the far limit of safety is obtained by the comparison of angles method.

Near limit

9. Explain that the near limit of safety is obtained as follows:—

(a) If the gun line is close to the crest, the near limit of safety is a point immediately beyond the crest behind which the guns are positioned, at which troops cannot be seen from the gun position. This point can be determined from the gun position by eye.

(b) If the guns are well back from a shallow crest, the near limit may be on the same side of the crest. In this case the near limit can be obtained by the comparison of angle method. As no ground angle can be measured direct, the angle of sight to own troops must be considered in relation to the angle of sight to the target.

Examples:—If the angle of sight to the target is greater than the angle of sight to own troops, the difference between them must be subtracted from the safety angle as in normal direct fire.

If the angle of sight to the target is a plus angle of sight, but less than the angle of sight to own troops, the difference between them must be added to the safety angle.

If the angle of sight to the target is a minus angle, the difference between that angle and the angle of sight to own troops must again be added to the safety angle.

Protective fire

10. The procedure for laying protective fire, from an indirect position, as close to own troops as possible is as follows:—

(a) Obtain the range and angle of sight to own troops.
(b) Find from the range tables the equivalent range to own troops.
(c) Lay the guns by indirect means for direction on own troops.
(d) For elevation, order the equivalent range and the angle of sight to own troops. Fire can thus be laid as close as possible to own troops, consistent with safety.

Winds

11. Head and rear winds will have the same effect as in direct fire. Therefore:—

(a) When engaging a target,
For head winds, no allowance is necessary.
For rear winds, allowance must be made.

(b) When laying down protective fire,
For head winds, allowance must be made.
For rear winds, no allowance is necessary.

Practice

12. Practise class in far limit problems.

13. Point out a near limit, with guns close to crest.

14. Practise the class in near limit problems when the guns are well back from the crest.

15. Practise the class in protective fire problems.

16. Practise the class in problems involving wind.

Conclusion

17. Questions to and from the class.

18. Sum up main points.

CHAPTER 19

PROTECTIVE FIRE—FIXED LINES

INTRODUCTORY NOTES

1. Machine guns, when in defence and when assisting in re-organization, must make preparations to fire on certain pre-arranged areas should the SOS be sent up during the night or should the arc of fire become obscured.

This pre-arranged fire is referred to as firing on fixed lines. Fixed lines can only be selected and laid intelligently if commanders have a thorough knowledge of their use and of the characteristics of beaten zones.

LESSON 105.—LAYING A FIXED LINE (FLANKING FIRE)

A INSTRUCTOR'S NOTES

Aim

1. To teach how to lay a fixed line as near as is safe to a defended locality by flanking fire.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

4. Lecture—Blackboard and chalk.
Practice—Gun, tripod, dial sight, belt with drill cartridges and aiming post.
Class require range tables.

Preparation

5. Draw the diagrams given below on the blackboard.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 page 46).

7. Show the class that fixed lines, flanking fire, may take either of two forms:—

(a) A belt of fire (*see* Fig 35 below). In this case, it will usually be necessary to give different elevations to each gun so as to make the belt of fire as long as possible. The elevations will be decided upon by consulting the range tables, so as to ensure that the beaten zones overlap. An example of this can be seen in Fig 35, where by ordering "**No. 1 gun 500, No. 2 gun 700,**" on flat ground the belt of fire can be stretched from 380 yards to 800 yards and the beaten zones yet overlap. This is one of the most valuable characteristics of the machine gun and should be utilised to the fullest extent. When laying a belt of fire, tapping right and left is not normally employed.

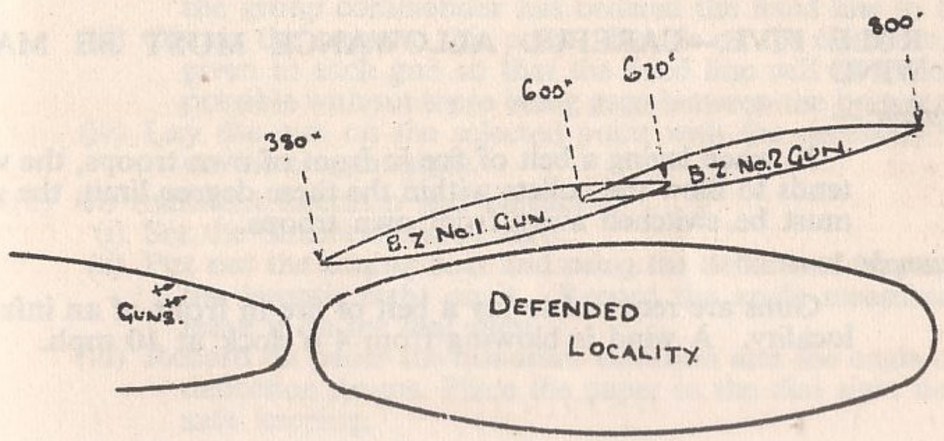


FIG 35

(b) At times it may be necessary to lay a fixed line on a bridge, cross-roads, narrow valley or some other place where the enemy is likely to concentrate. In such circumstances, it may be necessary to tap right and left in order to cover the whole width of the point to be engaged.

Rules

8. The rules for flanking fire apply to the laying of fixed lines, flanking, fire. There are however differences in the application of certain of these rules. These differences are discussed below.

9. RULE TWO.—BARRELS MUST NOT POINT NOR BULLETS FALL WITHIN THREE DEGREES OF OWN TROOPS.

Show that this implies that a belt of fire must not be laid closer than three degrees to any locality occupied by own troops. (*See* Fig 36).

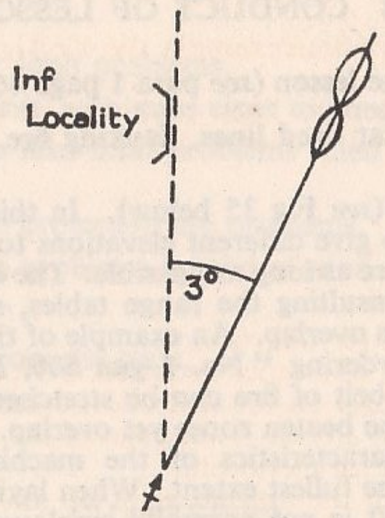


FIG 36

10. RULE FIVE.—CAREFUL ALLOWANCE MUST BE MADE FOR WIND

Explain:—

If, when laying a belt of fire in front of own troops, the wind tends to blow the bullets within the three degree limit, the guns must be switched away from own troops.

Example 1:—

Guns are required to lay a belt of fire in front of an infantry locality. A wind is blowing from 4 o'clock at 10 mph.

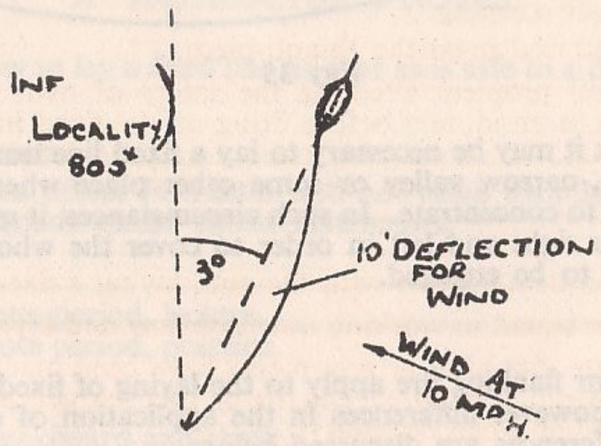


FIG 37

If the guns were laid only 3° from the locality, the wind would blow the bullets inside the 3° limit by 10'. The guns must therefore be switched 10' to the right.

Example 2:—

If, in the previous example, the wind had been blowing from the left, *ie*, away from our own troops, the guns should be laid 3° from the locality. They could not be laid closer to the locality as, if the wind suddenly dropped, the bullets would fall within the 3° limit.

Procedure

11. Explain the procedure in laying a gun on a fixed line as near as is safe to a defended locality.

(a) To lay the gun for direction.
- (i) The safety allowance required is 3°.
- (ii) Set this angle on the deflection drums and, using the lensatic sight, lay on the front edge of the defended locality.

(b) To lay the gun for elevation.
- (i) By running the tangent sight up and down, find the limit of flanking safety.
- (ii) Select a point either on or outside this line in the area where the group commander has ordered the fixed line to fall.
- (iii) Obtain the range to this point. Decide on the elevation to be given to each gun so that the fixed line will be as long as possible without there being gaps between the beaten zones.
- (iv) Lay the gun on the selected point with the necessary range on the tangent sight.

(c) To maintain direction and elevation.
- (i) Set the direction dial at zero.
- (ii) Put out the aiming post and using the deflection drums, align the lensatic sight on it. Record the angle measured and leave it on the dial sight.
- (iii) Record on paper the quadrant elevation and the angle on the deflection drums. Place the paper in the dial sight box for safe keeping.

(d) Half load and press the thumb-piece.

(e) Any wind problem affecting the safety of own troops must be borne in mind, and before firing on the fixed line the necessary wind allowance must be made, using the deflection drums, and re-laying the guns on the aiming post.

Practice

12. Explain and demonstrate with the gun, laying a fixed line.

13. Practise the squad in working out problems and laying fixed lines.

14. Demonstrate that after arrangements have been made to lay the gun on a fixed line, the gun, if required, can fire on other targets and yet be placed back on the fixed line when necessary.

15. Further practice in fixed line problems, including wind problems.

Conclusion

16. Questions to and from the squad.

17. Sum up main points.

LESSON 106.—LAYING A FIXED LINE, OVERHEAD FIRE

A INSTRUCTOR'S NOTES

Aim

1. To teach how to lay a fixed line as near as is safe to a defended locality by overhead fire.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

Lecture—Blackboard, and chalk.
Practice—Gun, tripod, dial sight, belt with drill cartridges and aiming post.
Class require range tables.

Preparation

5. Draw the diagram given below on the blackboard.

B CONDUCT OF LESSON

Aim

6. Give the aim of the lesson (*see* para 1 above).

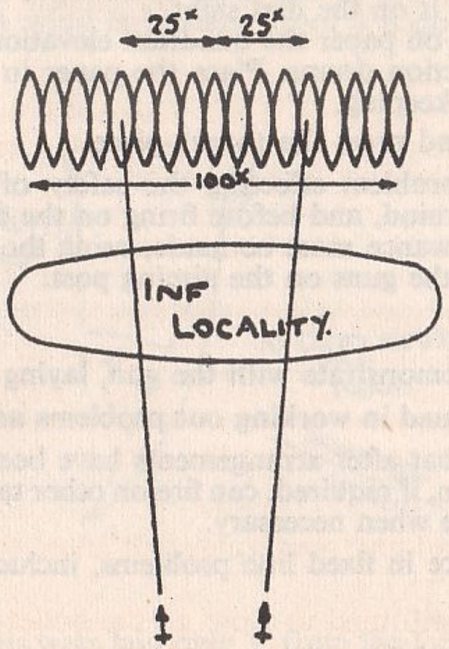


FIG 38

7. State that there may be occasions when it is desired to lay a mat of fire over the heads of own troops. In this case, the guns are laid a certain distance apart, normally 50 yards. Arrangements are made to tap the guns right and left so that the width of the mat is 100 yards (*see* Fig 38 above).

Rules

8. Tell the class that the rules for overhead fire apply to the laying of fixed lines, overhead fire.

Procedure

9. Describe the procedure for laying a gun on a fixed line (overhead fire) as near as is safe to a defended locality:—

(a) Obtain the range to the defended locality, and from the range tables obtain the equivalent range. Convert 25 yards at the equivalent range to an angle by means of the VI graph. Bring this angle to the nearest number of taps, if it does not come to an exact number, take it to the next highest.

(b) To lay the guns for direction.

(i) Set the angle obtained above on the deflection drum of the dial sight of No. 1 gun as right and of No. 2 gun as left.

(ii) Lay both guns by means of the lensatic sight on the centre of the defended locality. The direction of No. 1 gun is now 25 yards to the right of centre and of No. 2 gun 25 yards to the left of centre.

(c) To lay the guns for elevation.
Set the equivalent range on the tangent sight and lay the guns on the defended locality.

(d) To maintain direction and elevation.

(i) Put out the aiming post. Using the deflection drums, align the lensatic sight on it. Zero the tripod direction dial.

(ii) Record the quadrant elevation.

(iii) Note on paper the QE, the angle on the deflection drum and the number of taps right and left.
Place the paper in the dial sight box for safe-keeping.

(e) Half load and press the thumb-piece.

(f) Any wind problem affecting the safety of own troops must be calculated on the equivalent range. Before firing on the fixed line the necessary wind allowance must be made, using the range drum and relaying the gun.

Winds

10. Explain that head and rear winds will affect the laying of overhead fixed lines as follows:—

(a) Head winds will tend to slow up the bullet and cause it to drop below the safety angle. The equivalent range will therefore have to be increased accordingly.

(b) Rear winds will entail no adjustment to the equivalent range.

Practice

11. Revise the squad in the method of opening up the lines of fire to 50 yards apart and of calculating the number of taps required.

12. Revise the equivalent range.

13. Demonstrate the laying of a fixed line.

14. Practise the squad in calculating and laying a fixed line.

15. Demonstrate that, after arrangements have been made to lay guns on fixed lines, the guns can if required engage targets within the arc and yet be placed back on fixed lines if necessary.

16. Further practice, including wind problems.

Conclusion

17. Questions to and from the squad.

18. Sum up main points.

LESSON 107.—LAYING A FIXED LINE WHEN NO DAYLIGHT RECONNAISSANCE HAS BEEN POSSIBLE

A INSTRUCTOR'S NOTES

Aim

1. To teach the method of laying a fixed line by night when it has not been possible to make preparations in daylight.

Class and instructors

2. One officer instructor and not more than 30 in the class.

Periods

3. One 45-minute lecture.

Stores

4. No stores required.

B CONDUCT OF LESSON

Approach

5. Give the aim of the lesson (*see* para 1 above).

6. State that it may sometimes be required to lay a fixed line to protect a locality by night when no daylight reconnaissance or preparation has been possible. Such an occasion might arise after a night attack when machine guns are required to assist in re-organization. This may be carried out by either of the following methods dependent on the circumstances:—

Method 1

When no safety is involved and a light can be shown from the place at which the fire is required to fall, the following procedure will be adopted:—

(a) Shine a light from the area in which the fixed line is to fall.

(b) Obtain the range to the light by rangefinder.

(c) Lay the guns on the light, using the tangent sight set at the range obtained.

(d) Record the QE, and the angle between the line of fire and the aiming lamp and continue as in Lesson 105.

Method 2

When flanking safety is involved and a light can be shown from the front edge of the defended locality to be protected, then the following method can be adopted:—

(a) Shine a light from the front edge of the locality.

(b) Obtain the range to the light by rangefinder.

(c) Using the tangent sight set at the range obtained, lay the guns on the light.

(d) Set the deflection drums of the dial sights at the safety allowance and tap the guns until the lensatic sights are laid on the light.

(e) Record the QE.

(f) Set the dials of the tripods at zero. Put out the aiming lamp and, using the deflection drums, align the lensatic sight on it.

(g) Note the elevation and the angle measured. Half load and press the thumb-piece.

NOTE.—This method must NOT be used for OVERHEAD fire.

Conclusion

7. Questions to and from the class.

8. Sum up main points.

9. This lesson is best practised during section training at night.

CHAPTER 20

NIGHT FIRING

INTRODUCTORY NOTES

1. This chapter contains the arrangements to be made to engage a target at night. These arrangements can be applied to conditions of bad visibility such as fog or smoke.

2. The following are the occasions on which machine guns may be required to fire at night:—

(a) When sections are in direct fire positions before darkness falls, with guns laid and aiming posts planted. In order to be able to fire on a fixed line during the night, aiming lamps must be put out (*see* lesson 73).

(b) When sections are required to occupy positions by night ready to fire on fixed lines. To lay the guns on their fixed lines, lights must be shown either from the place on which the fixed line is to fall or from a locality to be protected (*see* lesson 107).

(c) When a group is in an indirect fire position before darkness falls with guns on zero lines. In order to engage targets during the night, aiming lamps must be put out and fire control charts prepared (*see* lesson 80 and 118).

(d) When a group is required to occupy a position by night to engage a target or series of targets, but the reconnaissance of the position can be carried out in daylight (*see* lesson 108).

LESSON 108.—RECONNAISSANCE AND PREPARATION OF A NIGHT FIRING POSITION

A INSTRUCTOR'S NOTES

Aim

1. To teach how to obtain the necessary data and to prepare a position for engaging targets by night.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

4. Lecture—Blackboard, chalk and director.
Practice—Directors, gun flags, four zero posts and four direction pegs.

Preparation

5. Draw the diagrams given on the following pages.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 above).

Obtaining data

7. State that before darkness falls, all data to engage the various targets must be obtained. This will include some or all of the following:—

Angles of sight and ranges.
Angular width of targets.
Angles of switch from zero line to targets.
Data affecting safety.
Magnetic bearing of the zero line (this is required as a check to prevent a major error).

8. Explain the methods of recording data. An example is given in Fig 39 below.

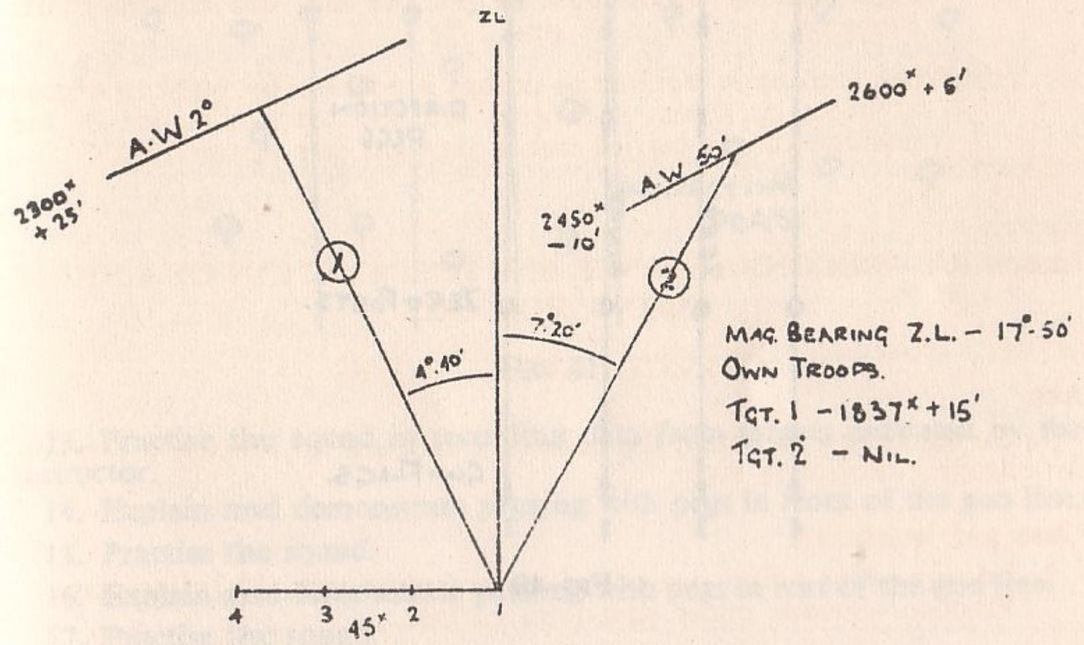


FIG 39

Pegging the position

9. State that before dark the position must be pegged as follows:—

(a) A gun position and zero line are selected. As the position will not be occupied until after dark, the zero line of each gun will have to be marked by zero posts and direction pegs.

(b) Mount a director so that the hairline can just be laid on the zero line for the pivot gun; all drums and dials must be at zero. Swing the director through 180° and get an assistant to plant a direction peg accurately in line with the hairline about 15 yards away. A zero post is planted in a similar manner about 30 yards away, and then the gun flag another 15 yards away.

When engaging targets of less width than the gun frontage the procedure should be as given in Lesson 112.

(c) Mount the director over the pivot gun flag, lay it through the zero line, with the direction dial sight at 180°, and put out the remaining gun flags. Using the deflection drums, swing the director on to each of the other gun flags and note the angles on paper.

(d) Mount the director over each of the other gun flags in turn and with dials and drums at zero lay the hair line on the pivot gun flag and lock the head. Apply the angle measured previously to the director and get an assistant to plant out first a zero post and then a direction peg accurately in line with the hairline. The zero line for each gun will then be pegged as in Fig 40 below.

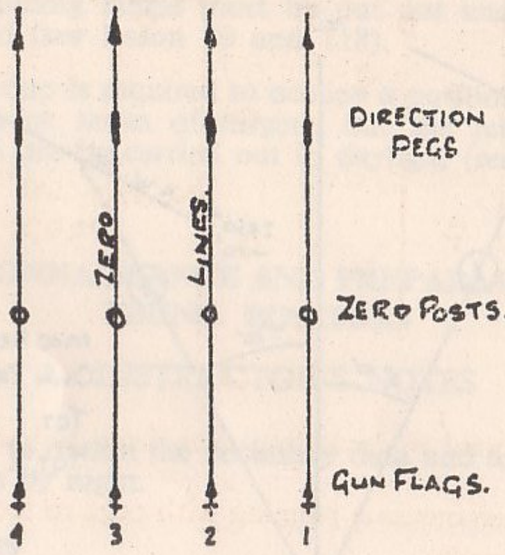


FIG 40

10. Sometimes a position may be selected on the front edge of cover which is in view of the enemy. To avoid exposing personnel in front of the cover, it will be necessary to place the direction pegs and zero posts in rear of gun flags (*see* Fig 41).

In this case, to peg the zero line for the pivot gun, the director should be mounted over the pivot gun flag and laid on the zero line with the deflection drums and dials at zero. It should then be swung through 180° and the post and peg placed on this line. The angles to the remaining guns are then read off and pegs and posts placed out as before.

Occupation

11. After dark when the guns are brought up, the procedure is as described in Lessons 81 and 82.

Practice

12. Revise the method of recording data.

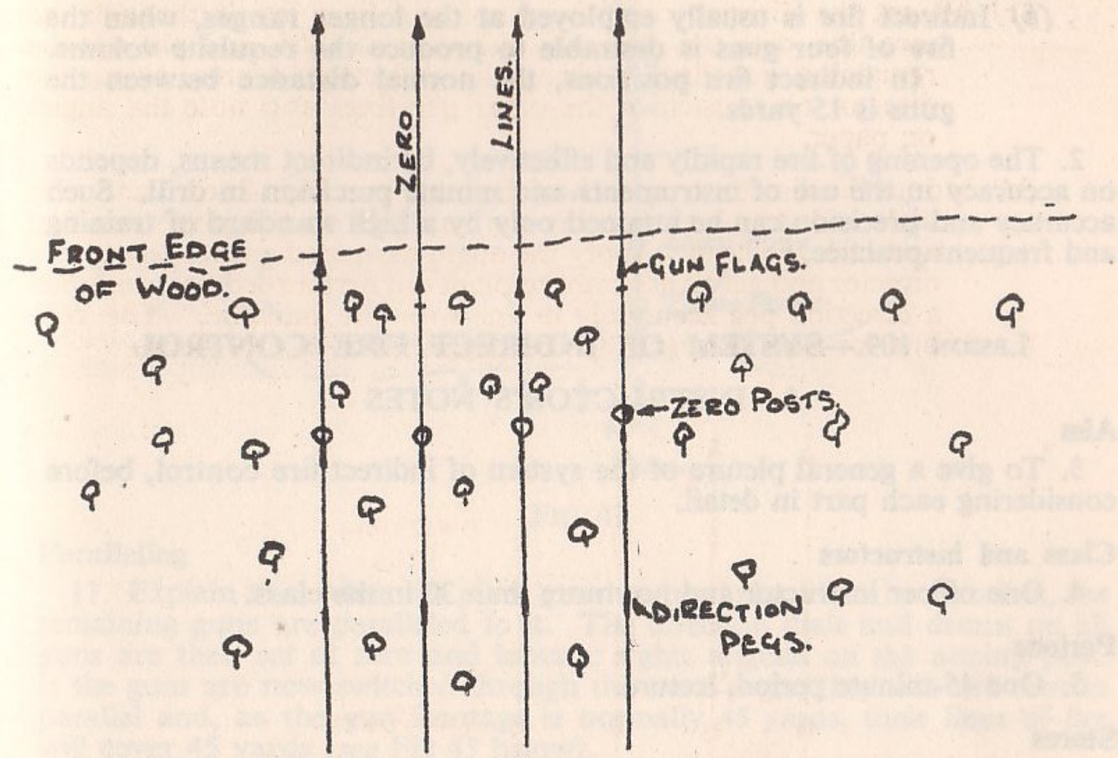


FIG 41

13. Practise the squad in recording data from targets indicated by the instructor.

14. Explain and demonstrate pegging with pegs in front of the gun line.

15. Practise the squad.

16. Explain and demonstrate pegging with pegs in rear of the gun line.

17. Practise the squad.

18. Further practice as required.

Conclusion

19. Questions to and from the squad.

20. Sum up main points.

CHAPTER 21

INDIRECT FIRE

INTRODUCTORY NOTES

1. The indirect fire unit is normally the group of two or more sections, because:—

(a) The gun position is not in view of the enemy, and therefore the concealment and control of four guns is possible.

(b) Indirect fire is usually employed at the longer ranges, when the fire of four guns is desirable to produce the requisite volume.
In indirect fire positions, the normal distance between the guns is 15 yards.

2. The opening of fire rapidly and effectively, by indirect means, depends on accuracy in the use of instruments and minute precision in drill. Such accuracy and precision can be attained only by a high standard of training and frequent practice.

LESSON 109.—SYSTEM OF INDIRECT FIRE CONTROL

A INSTRUCTOR'S NOTES

Aim

3. To give a general picture of the system of indirect fire control, before considering each part in detail.

Class and instructors

4. One officer instructor and not more than 30 in the class.

Periods

5. One 45-minute period, lecture.

Stores

6. Blackboard and chalk.

Preparation

7. Draw the diagrams given below on the blackboard.

B CONDUCT OF LESSON

Approach

8. Explain the introductory notes and give the aim of the lesson (*see* para 1 above).

Pivot gun

9. State that No. 1 gun, the righthand gun, is always used in indirect fire as the basis for calculations. It is known as the pivot gun.

Zero line

10. Explain that to obtain direction in indirect fire, an object is selected in the centre of the arc. The line from No. 1 gun to this object is called the zero line. Once the pivot gun has been laid on this line, the group commander, by measuring the angle between the zero line and a target and ordering the pivot gun to swing through this angle, can get the gun laid on the target. To ensure accurate measurement of switches, the object selected for the zero line should be easily recognizable and clearly defined.

As the object selected for the zero line, will rarely be visible from the gun position, the line is prolonged into the gun position by means of zero posts (*see* Fig 42). If the pivot gun is mounted so that it is laid directly through the zero posts, it will then be laid on the zero line.

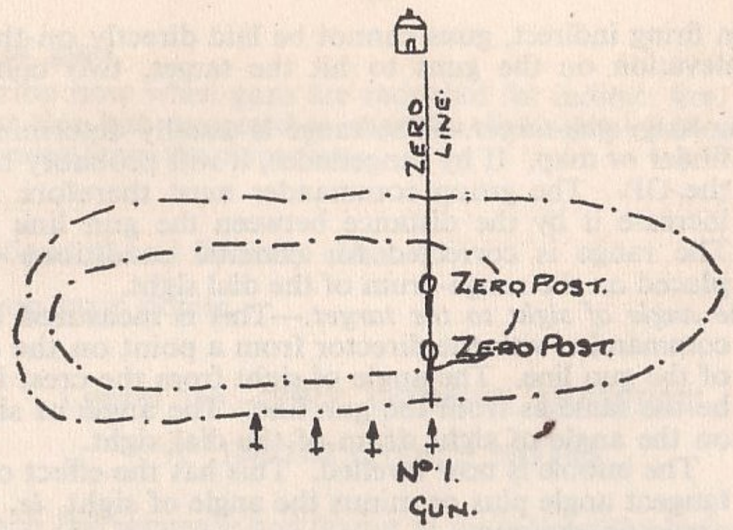


FIG 42

Paralleling

11. Explain that when the pivot gun has been placed on its zero line, the remaining guns are paralleled to it. The direction dials and drums on all guns are then set at zero and lensatic sights aligned on the aiming post. If the guns are now switched through the same angle, they will still remain parallel and, as the gun frontage is normally 45 yards, their lines of fire will cover 45 yards (*see* Fig 43 below).

At any time, the guns can be put back on their zero lines by re-setting direction drums and dials at zero and tapping the guns until their lensatic sights are back on the aiming posts.

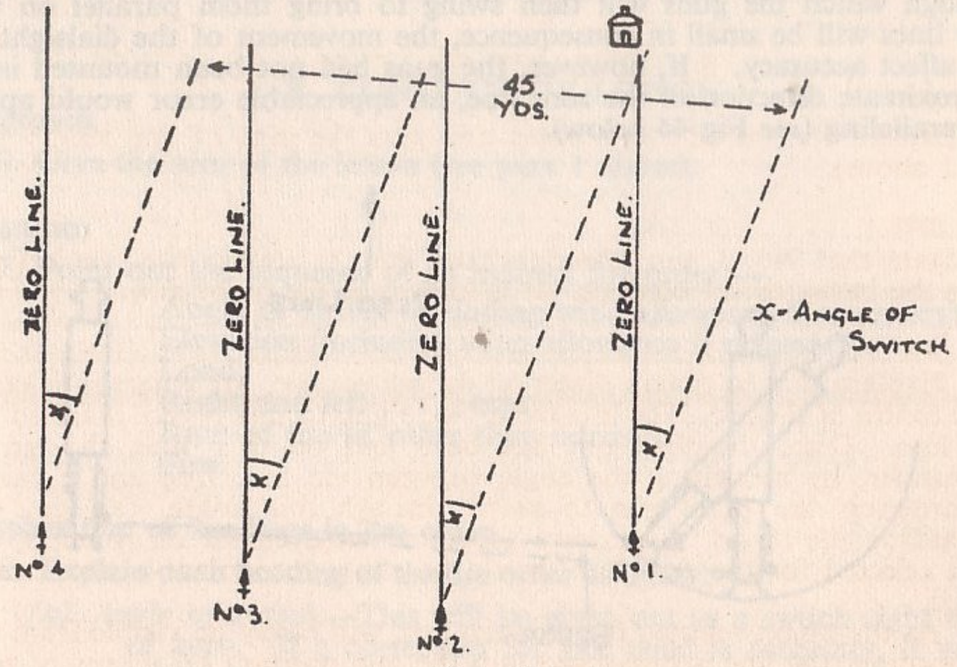


FIG 43

Elevation

13. When firing indirect, guns cannot be laid directly on the target. To place the elevation on the guns to hit the target, two components are required:-

(a) The range gun-target.—The range is usually determined by rangefinder or map. If by rangefinder, it will probably be taken from the OP. The group commander must therefore remember to increase it by the distance between the gun line and the OP. The range is corrected for climatic conditions before being placed on the range-drum of the dial sight.

(b) The angle of sight to the target.—This is measured by the group commander with the director from a point on the crest in front of the gun line. The angle of sight from the crest is assumed to be the same as from the gun line. The angle of sight is placed on the angle of sight drum of the dial sight.

The bubble is now levelled. This has the effect of placing the tangent angle plus or minus the angle of sight, *ie*, the quadrant angle on the gun.

Crest clearance

14. Tell the class that on all occasions on which an indirect position is occupied, it must be ensured that the guns will clear the crest. This is done by comparing the lowest elevation required in engaging the target, with the lowest elevation that will allow the cone of fire to clear the crest.

Direction of guns

15. State that as the dial sight is not attached to the gun at the point at which the gun pivots, the dial sight moves in an arc when the gun is swung through an angle. To avoid inaccuracies resulting from this, the guns must be mounted approximately in the direction of the zero line. As the angle through which the guns will then swing to bring them parallel on their zero lines will be small in consequence, the movement of the dialsight will not affect accuracy. If, however, the guns had not been mounted in the approximate direction of the zero line, an appreciable error would appear in paralleling (*see* Fig 44 below).

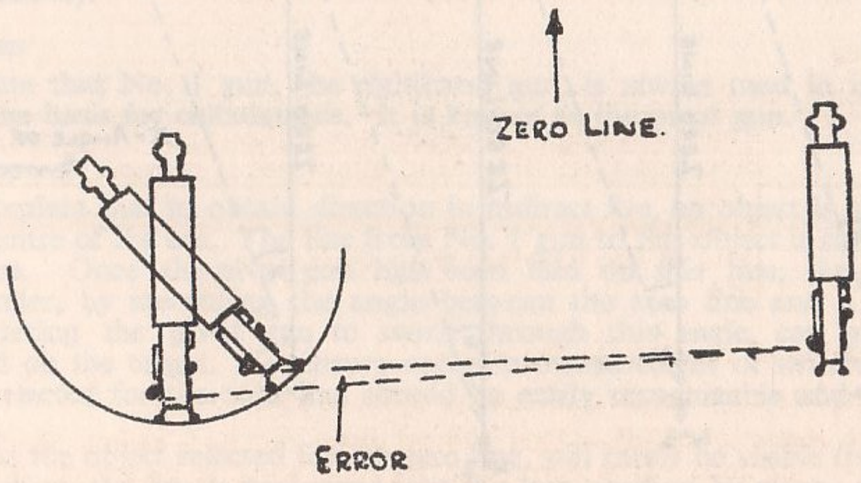


FIG 44

Staggering of guns

16. Describe how when guns are mounted for indirect fire, they are not in a straight line but staggered so that the dial sights of Nos. 2, 3, and 4 guns can be seen from the pivot gun.

Conclusion

17. Questions to and from the class.

18. Sum up main points.

LESSON 110.—FIRE ORDERS, INDIRECT

A INSTRUCTOR'S NOTES

Aim

1. To teach the sequence and layout of an indirect fire order.

Class and instructors

2. One officer instructor and not more than 30 in the class.

Periods

3. One 45-minute period, lecture.

Stores

4. Blackboard and chalk.

Preparation

5. Write the sequence of a fire order on the blackboard.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 above).

Sequence

7. Point out the sequence of an indirect fire order:—

Angle of switch (including wind allowance if necessary).
Elevation (including wind allowance if necessary).
Load.
Right and left . . . . . taps.
Rate of fire (if other than normal).
Fire.

Explanation of headings in fire order

8. Explain each heading of the fire order as under:—

(a) Angle of switch.—This will be given out as a switch right or left of zero. If a correction for side wind is necessary, it will be added to, or subtracted from, the switch before the latter is given out. Angles of switch are given to the nearest 10 minutes.

Examples:—

" All, one two degrees two owe minutes left of zero "
" All, three degrees five owe minutes right of zero "

(b) Elevation.—If a correction for atmospheric conditions or for wind is necessary, it will be added to, or subtracted from, the range before the latter is given out. Angles of sight are given to the nearest five minutes.

Examples:—

" All, one eight fifty plus three owe minutes "
" All, one six hundred minus four five minutes "
" All, one seven hundred, angle of sight zero "
" Nos 1 and 2 guns, one five fifty plus three owe minutes, Nos 3 and 4 guns, one five fifty plus two owe minutes "

(c) Right and left . . . . . taps.—The number of taps varies with the width of the target. Nos. 1 and 3 guns will always tap to the right first; Nos. 2 and 4 guns to the left.

Orders during a shoot

9. Corrections to direction will be given out in the form:—
" All, left three owe minutes "
Corrections to elevation will be given out in the form:—
" All, down fifty "
" All, up one hundred "
These orders may be given out verbally or by signal.

Duties of senior section commander

10. During the issue of indirect fire orders, the senior section commander is responsible for:—

(a) Repeating back all fire orders to the group commander before passing them on to the guns.

(b) Following all fire orders by recording all angles, switches etc. He should periodically check direction and elevation by ordering—
" Check direction and elevation—you should now read—direction . . . . degrees . . . . . minutes, right (or left) of zero, and elevation . . . . . yards, plus (or minus) . . . . . degrees . . . . . minutes."

(c) After each heading of the fire order has been complied with, reporting **" Ready "** to the group commander as an indication that he is ready to receive the next heading of the fire order.

(d) Calculating and reporting the minimum quadrant angle (MQA) (*see* lesson 115).

(e) Ordering the range at which Nos. 1 will check for crest clearance.

Conclusion

11. Questions to and from class.

12. Opportunity can be taken during lessons 111 to 114 to practise the correct issue of fire orders.

13. Sum up main points.

LESSON 111.—PARALLELING

A INSTRUCTOR'S NOTES

Aim

1. To teach the system of placing guns on parallel zero lines.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

4. Blackboard and chalk, for lecture.
For practice, two guns, two tripods, two dial sights, two zero posts, two aiming posts, gun flags and portable blackboard.

Preparation

5. Lecture—Draw the diagrams given below.
Practice—Lay out gun line. Mount one gun behind No. 1 gun flag and one gun behind No. 4 gun flag.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 above).

Theory of paralleling

7. Explain:—

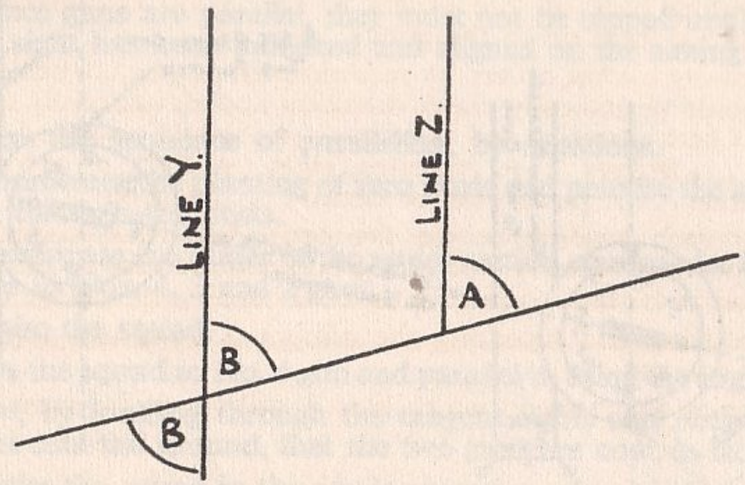


FIG 45

In Fig 45, if the angles B can be made equal to the angle A, then the line Y is automatically parallel to the line Z. This mathematical principle is applied in paralleling machine guns as follows:—

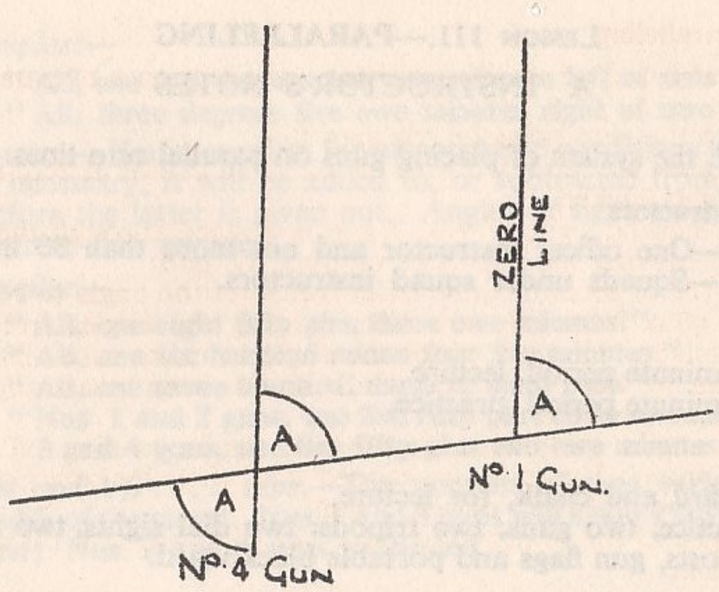


FIG 46

No. 1 gun is laid with the dial sight on its zero line. The angle A is then measured and ordered to No. 4 gun as " Left A degrees." Left A degrees is set on the direction dial and drums of No. 4 gun, making an angle of A degrees between the barrel of the gun and the lensatic sight.

The gun is then tapped until the lensatic sight is aligned on the dial sight of No. 1 gun; No. 4 gun is thus made parallel to No. 1 gun.

The measuring of the Angle A on the dial sight of No. 1 gun and the setting of it on the dial of No. 4 gun is shown in Fig 47 below.

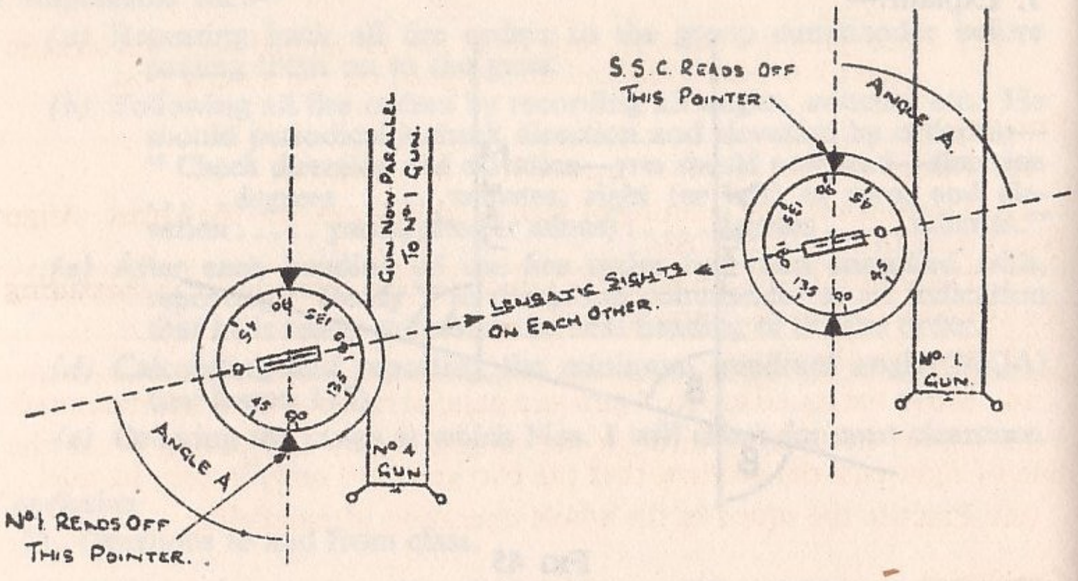


FIG 47

The same process is then repeated for the remaining guns. For the sake of convenience the order of paralleling is Nos. 4, 3, and 2 guns.

Method of paralleling

8. State that based on the above theory, the sequence of paralleling is as follows:—

(a) Align the zero posts on the zero line.
(b) The guns are mounted with all dials and drums at zero and lensatic sights locked.
(c) The lensatic sight of No. 1 gun is aligned through the zero posts by moving the tripod or tapping the gun.
(d) The senior section commander measures the angle to Nos. 4, 3 and 2 guns from the zero line, reading the angles from the front pointer. He then closes the angle to make sure that No. 1 gun has not been disturbed whilst he has been measuring the angles from the other guns.
(e) The angles are placed on the dial sights, reading off the REAR pointer. The guns are tapped until their lensatic sights are laid on the dial sight of No. 1 gun.
(f) All drums are returned to zero. All guns are now on parallel zero lines.
(g) To maintain direction lensatic sights are now unlocked and aligned on the aiming posts.

Rules of paralleling

9. Emphasize that if the following rules are remembered and followed, there can be no errors in paralleling:—

(a) Before paralleling begins, all dials and drums must be at zero and lensatic sights locked.
(b) The senior section commander reads off the FRONT pointer on the dial, the Nos. 1 off the REAR.
(c) When the guns have been paralleled, all drums and dials are again placed at zero.
(d) Once guns are parallel, they must not be tapped until the lensatic sight has been unlocked and aligned on the aiming post.

Practice

10. Revise the sequence of paralleling, by questions.

11. Demonstrate the planting of zero posts and practise the squad. Align No. 1 gun through the posts.

12. Demonstrate the duties of the senior section commander in measuring the switches to Nos. 4, 3 and 2 guns.

13. Practise the squad.

14. Move the squad to No. 4 gun and parallel it, using the angle measured.

15. Show, by looking through the tangent sights and noting where the line of sight cuts the ground, that the two guns are now, in fact, parallel.

16. Practise the squad in the whole operation of paralleling.

Conclusion

17. Questions to and from squad.

18. Sum up main points.

LESSON 112.—TARGETS OF EQUAL OR LESS WIDTH THAN THE GUN FRONTAGE

A INSTRUCTOR'S NOTES

Aim

1. To teach the method of engaging a target of not greater width than the gun frontage, by indirect fire.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

4. Lecture—Blackboard and chalk.
Practice—One director per two men and portable blackboard.
Class require range tables.

Preparation

5. Draw the diagrams given below and on page 67 on the blackboard. For the practice, the instructor should select zero line and targets and prepare fire orders.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 above).

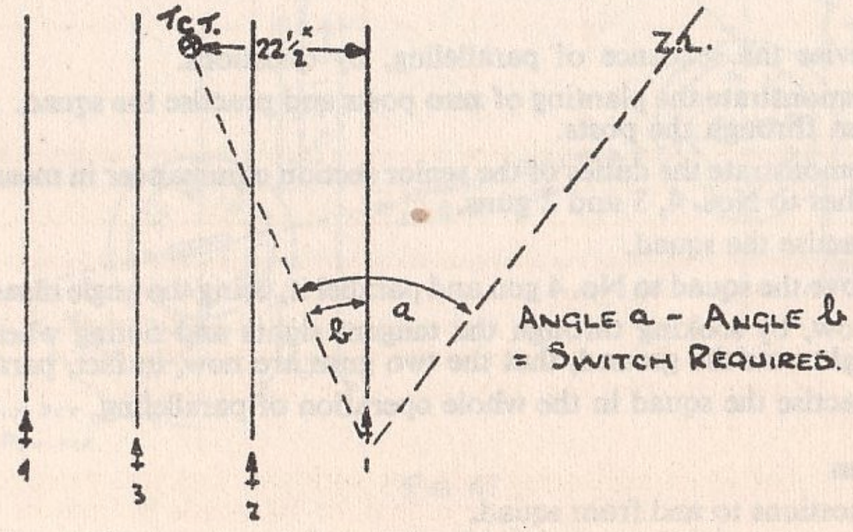


FIG 48

Direction

7. Explain that when engaging a point target or a target of less width than the gun frontage, the parallel lines of fire of the four guns should be so laid that they straddle the target. As the lines of fire normally cover a frontage of 45 yards, the line of fire of No. 1 gun should fall 22½ yards to the right of the centre of the target (*see* Fig 48).

To lay his guns for direction, the group commander should measure the angle between the zero line and the centre of the target with the director. When measuring angles, the director should as far as possible be mounted at a position in front of No. 1 gun. The group commander should then obtain from the VI table in the range graph what 22½ yards subtends as an angle at the range gun—target.

By subtracting this from the angle between the zero line and the centre of the target, he will obtain the switch required. This switch will be ordered **" All . . . . degrees . . . . minutes left of zero."**

Should the target be on the right of the zero line, the angle subtended by 22½ yards at the range gun—target must be ADDED to the angle between the zero line and the centre of the target (*see* Fig 49 below).

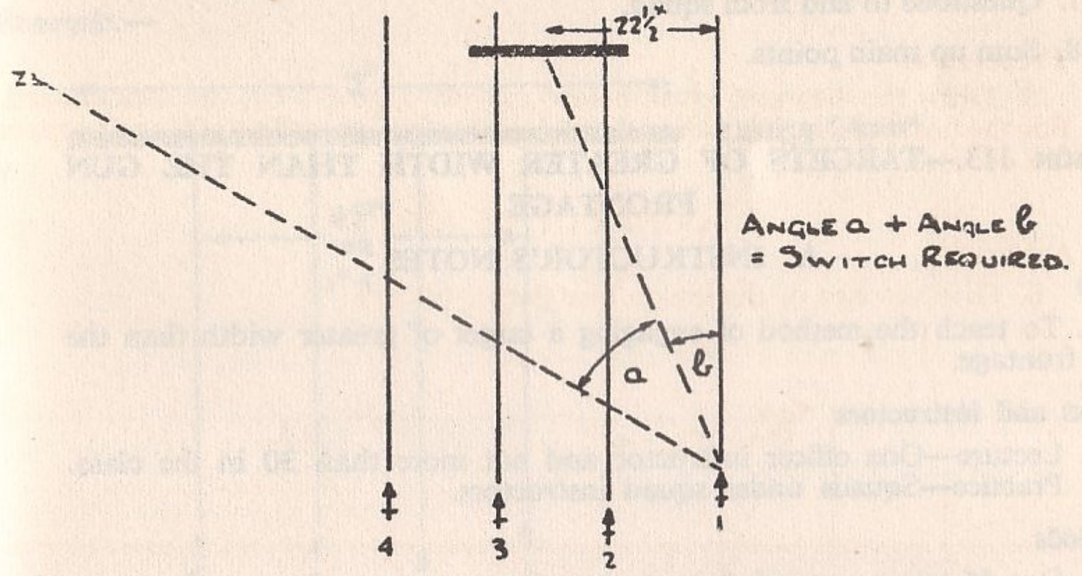


FIG 49

8. Explain that if the target is of equal width to the gun frontage, then obviously the line of fire of No. 1 gun must be laid on the right end of the target. In this case, the group commander has simply to measure the angle between the zero line and the right end of the target and order this switch to the guns.

9. State that when measuring switches with the director, provided it is mounted not more than 30 yards to a flank or 100 yards in front or rear of the pivot gun, errors due to displacement will be negligible.

Tapping

10. Tell the class that to cover the gaps between the lines of fire and to cater for errors in direction, guns are tapped right and left one tap.

Elevation

11. State that elevation is ordered to the guns as laid down in Lesson 110. If no strike is observed, the combined sight rule is applied.

Practice

12. Revise the lesson by questions.

13. Indicate the zero line and a target and give the range.

14. The squad should now measure the switch and angle of sight and work out the fire order.

15. Question the squad on the fire order and discuss it.

16. Repeat this process with other targets, including wind problems.

Conclusion

17. Questions to and from squad.

18. Sum up main points.

LESSON 113.—TARGETS OF GREATER WIDTH THAN THE GUN FRONTAGE

A INSTRUCTOR'S NOTES

Aim

1. To teach the method of engaging a target of greater width than the gun frontage.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

4. Lecture—Blackboard and chalk.
Practice—One director per two men and portable blackboard.
Class require range tables.

Preparation

5. Draw the diagrams given in Figs 50 and 51 on the blackboard.
For practice, the instructor should select zero line and targets and prepare fire orders.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 page 68).

Direction

7. Explain that to engage a target of greater width than the gun frontage, the system is to lay the parallel lines of fire on the centre of the target and to cover the extra width of the target by tapping right and left.

To lay the parallel lines of fire astride the target, the group commander should proceed as in Lesson 112 para 7.

8. State that to discover the number of taps required to cover the extra width of the target, the group commander must measure the width of the target. From this, he should subtract the angle subtended by 45 yards at the range gun-target. This will give him the angle subtended by the extra width. Dividing this by two will give him the amount not covered by fire at each end of the target. This amount should be brought to the nearest number of taps. One extra tap should be added to cover errors in direction, and the total number of taps ordered to the guns in the form "**Right and left . . . . . taps.**"

Example:—

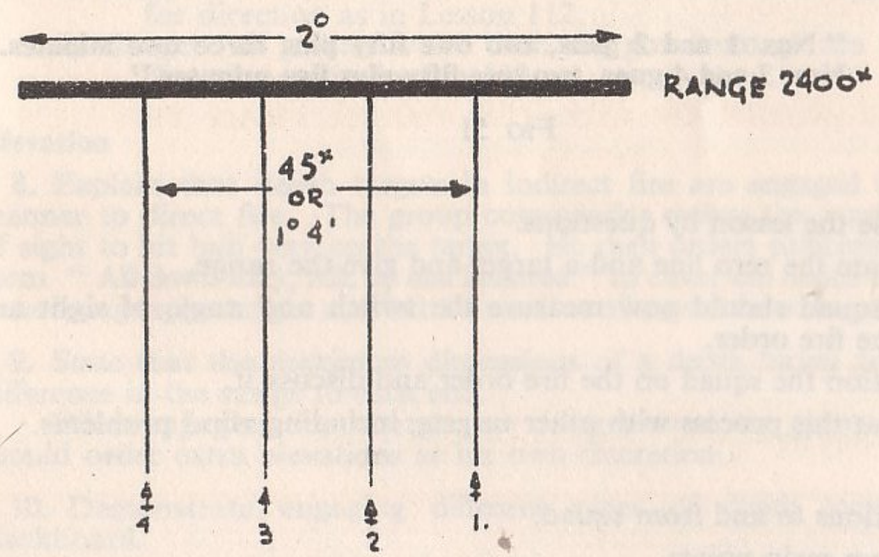


FIG 50

Angular width target = 2°
45 yards at 2400 yards subtends = 1° 4′
Extra width = 56′

Amount not covered each end = $\frac{56}{2}$ = 28′ or two taps.

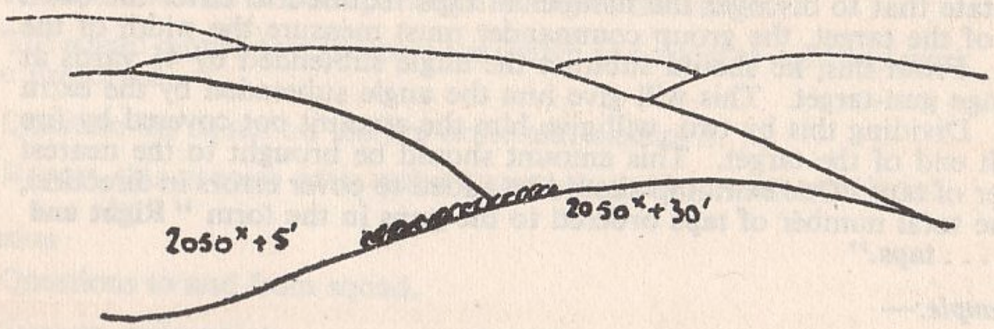
Add one tap to cover errors in direction . . . . three taps.
Order "**Right and left 3 taps.**"

9. Tell the class that four guns should not engage a target requiring more than right and left 4 taps. If a target exceeds this, it should be split up and be engaged as separate targets.

Elevation

10. State that elevation is ordered to the guns as laid down in Lesson 110. If no strike is observed, the combined sight rule is applied.

11. Explain that should a target of greater width than the gun frontage have a different angle of sight but the same range to each end, the angle of sight to the right end will be ordered to Nos. 1 and 2 guns and the angle of sight to the left end to Nos. 3 and 4 gun (*see* Fig 51 below).



"Nos 1 and 2 guns, two owe fifty plus three owe minutes. Nos 3 and 4 guns, two owe fifty plus five minutes."

FIG 51

Practice

12. Revise the lesson by questions.

13. Indicate the zero line and a target and give the range.

14. The squad should now measure the switch and angle of sight and work out the fire order.

15. Question the squad on the fire order and discuss it.

16. Repeat this process with other targets, including wind problems.

Conclusion

17. Questions to and from squad.

18. Sum up main points.

LESSON 114.—DEPTH TARGETS

A INSTRUCTOR'S NOTES

Aim

1. To teach the method of engaging depth targets by indirect fire.

Class and instructors

2. Lecture—One officer and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

4. Lecture—Blackboard and chalk.
Practice—One director per two men and portable blackboard.
Class require range tables.

Preparation

5. Draw the diagrams given below on the blackboard.
For the practice, the instructor should select zero line and targets and prepare fire orders.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson *(see* para 1 above).

Direction

7. State that:—
(a) Targets, of equal or less width than the gun frontage, are engaged for direction as in Lesson 112.
(b) Targets of greater width than the gun frontage are engaged for direction as in Lesson 113.

Elevation

8. Explain that depth targets in indirect fire are engaged in a similar manner to direct fire. The group commander orders the range and angle of sight to hit half-way up the target. He then orders sufficient lifts in the form **"All down fifty, All, up one hundred"** to cover the depth of the target, guns being tapped right and left the number of taps ordered at each elevation.

9. State that the maximum dimensions of a depth target are 200 yards difference in the range to each end.
When engaging depth targets on rising ground, the group commander should order extra elevations at his own discretion.

10. Demonstrate engaging different types of depth targets on the blackboard.

Practice

11. Revise the lesson by questions.

12. Indicate the zero line and a target and give the range.

13. The squad should now measure the switch and angle of sight and work out the fire order.

14. Question the squad on the fire order and discuss it.

15. Repeat this process with other targets, including wind problems.

Conclusion

16. Questions to and from squad.
17. Sum up main points.

LESSON 115.—CREST CLEARANCE

A INSTRUCTOR'S NOTES

Aim

1. To teach the method of determining whether the bullets will clear the crest in front of the guns.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

4. Lecture—Blackboard and chalk.
Practice—Two guns and tripods, two dial sights, two directors.
Class will require range tables.

Preparation

5. Draw the diagram given on page 73 on the blackboard.
For practice, select an area with a suitable crest.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 above).

7. State that the responsibility for ensuring that the bullets will clear the crest is primarily the group commander's; the senior section commander has however certain responsibilities in this respect, and as a matter of drill, should always ensure that the bullets will clear the crest.

8. Explain that it is not always necessary or practicable for the group commander to resort to the measurement by instruments and calculation of crest clearances during his reconnaissance for the gun position. With practice it is usually possible to judge how far back the gun position can be without the risk of bullets failing to clear the crest. As a rough guide, if the group commander walks up the crest until he can just see the target and then sites the gun line three paces in rear, the guns should just clear the crest and yet the gun position be indirect to the target.

If however, the range is short and the slope steep, it is advisable for the group commander to determine the minimum quadrant angle and to compare it with the lowest quadrant angle that he may require to engage his target, before deciding on his gun line. The procedure for doing so is given on page 73.

9. The senior section commander should always determine the minimum quadrant angle and report this to the group commander when reporting **"Guns on zero lines."**

Theory of crest clearance

10. Tell the class that in order to lay a gun so that it would hit the crest, the range to the crest would be placed on the range drum, the angle of sight to the crest placed on the angle of sight drum of the dial sight and the bubble levelled. If the gun was now fired, the lower half of the cone of fire would strike the crest (*see* Fig 52 below).

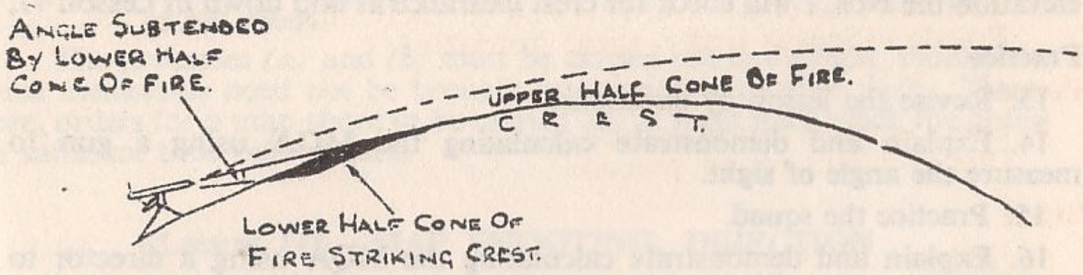


FIG. 52

Therefore, to lay the gun so that it will just clear the crest, the barrel must be lifted through the angle subtended by the lower half of the cone of fire at the range gun-crest.

Thus we have on the gun:—

(a) Tangent angle for the range to the crest.

(b) Angle subtended by half the cone of fire at that range.

(c) Angle of sight to the crest.

(a) and *(b)* are constant for any given range and when added together are called the crest clearance angle. Crest clearance angles for all ranges from 50 to 4000 yards are given in the range tables.

Thus the minimum quadrant angle (the lowest angle that can be placed on the gun which will ensure that the whole of the cone of fire clears the crest) is composed of:—

The angle of sight to the crest and the crest clearance angle for the range to the crest.

Procedure

11. State that:—

(a) Immediately the guns are in position, the senior section commander will order the No. 1 of the gun lowest down the crest to measure the angle of sight to the highest part of the crest over which the guns will fire.

(b) The senior section commander will ascertain the range to the crest by estimation or range-finder, look up the crest clearance angle for this range and add it to the angle of sight to the crest. He will then report this angle, the minimum quadrant angle (MQA), to the group commander, who will compare it with the lowest angle he will employ to engage the target. If the lowest quadrant angle is equal to or greater than the MQA the guns will clear the crest.

(c) If necessary, the group commander can calculate the MQA before the guns come into action, measuring the angle of sight to the crest with the director.

12. Tell the class that after the guns have been laid for direction and elevation the Nos. 1 will check for crest clearance as laid down in Lesson 77.

Practice

13. Revise the lesson by questions.

14. Explain and demonstrate calculating the MQA using a gun to measure the angle of sight.

15. Practice the squad.

16. Explain and demonstrate calculating the MQA using a director to measure the angle of sight.

17. Practice the squad.

18. Practice the squad in comparing the MQA with the lowest quadrant angle.

Conclusion

19. Questions to and from squad.

20. Sum up main points.

CHAPTER 22

MAP SHOOTING

INTRODUCTORY NOTES

1. Accurate shooting from the map is only possible when a map of scale 1/25,000 or larger is available. Where accuracy is not essential, for example for the engagement of areas well removed from the position of our own troops, maps of smaller scale can be used, but it should be noted that the detail on such maps is not usually surveyed in.

2. The principle of map shooting is that all calculations both for direction and for elevation are made from the map. The method has certain advantages, namely:—

No observation is necessary.
Targets can be engaged that cannot be seen from the ground.
Preparations can be made to open fire before the actual targets have been located.
Any number of targets can be engaged by switches.
It is just as flexible by night as by day.

It has also certain disadvantages, namely:—

1/25,000 maps are not always available.
Maps are liable to distortion.
Accurate location of points on the map is often difficult.
Corrections by observation of fire are not possible, there being no OP.

3. The method entails:—

(a) Location of the pivot gun on the ground, and marking its position on the map.

(b) Laying out the zero line for the pivot gun, or for all guns if a night shoot is required.

(c) Location of target or targets on the map and calculating the data to hit them.

The processes *(a)* and *(b)* must be carried out in daylight, though the guns themselves need not be brought into action until after dark. Therefore, orders for a map shoot to be carried out at night must reach the group in sufficient time before dark.

LESSON 116.—MAP SHOOTING, DIRECTION

A INSTRUCTOR'S NOTES

Aim

1. To teach how to lay out the gun position and to obtain from the map the direction to hit the target.

Class and instructors

2. Lecture—One officer instructor and not more than 30 in the class.
Practice—Squads under squad instructors.

Periods

3. One 45-minute period, lecture.
One 45-minute period, practice.

Stores

4. Blackboard and chalk, for lecture. The class require range tables, maps, sharp pencils and tracing paper.
Practice—Director, compass, zero posts, direction pegs, gun flags and a short wooden post.

Preparation

5. Prepare a map shoot to be used as an example when teaching this and the ensuing lesson. The class should work out the example on their maps after each stage of the lesson.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 above).

7. Explain the introductory notes to the chapte.r

Location of the pivot gun on the map

8. State that the position of the pivot gun can be fixed on the map by:—

(a) Resection, using one of the following methods:—

(i) Resector protractor.
(ii) Tracing paper.
(iii) Compass.

(b) By comparing the detail on the ground with the detail on the map.

(c) By artillery survey, if available.

9. Revise, by questions, resection by the resector protractor (*see* Lesson 44).

10. Make sure that the class understand how to resect by compass (*see* Manual of Map Reading, Photo Reading and Field Sketching 1929).

11. Explain and demonstrate resection by tracing paper. This is done by drawing on a sheet of tracing paper three lines meeting at one point and making angles measured by the director as in the resector protractor. The three lines on the tracing paper are then used as if they were the three arms of the resector protractor.

12. State that, when time permits, a greater accuracy is attained by employing one method and checking with another.

Placing guns on zero lines

13. Tell the class that a zero line is selected on the map in the centre of the target area. The pivot gun can be placed on this zero line by either:—

(a) Use of a reference point which can be seen on the ground and located on the map, or

(b) If no suitable reference point can be found, by compass.

14. Explain how to place the pivot gun on its zero line by the use of a reference point:—

On the map, draw the lines joining the pivot gun to the point selected for its zero line. On the map, draw the line joining the pivot gun to the reference point. Measure the angle between the two lines with a protractor.

Mount a director over No. 1 gun flag with its drums and dials at zero. Lay it on the reference point still at zero, and then swing it through the angle measured. Place a zero post and a direction peg using the hairline as in Lesson 108.

15. Explain how to place the pivot gun on its zero line by compass:—

On the map draw the line joining the pivot gun to the point selected for the zero line. Measure the grid bearing of the zero line with a protractor. Convert this to a magnetic bearing by adding the magnetic variation if the variation is West—by subtracting if the variation is East. Add or subtract the compass error (if any).

Place a wooden peg in the position of No. 1 gun and rest the compass on this peg, rotating it until it is laid on the required bearing. Align a zero post and a direction peg, using the hairline on the compass in the same way as the hairline of the director.

16. State that when the guns arrive, they are paralleled on their zero lines in the normal manner. If the guns are not coming into action until after dark, posts and pegs must be put out for all guns as in Lesson 108.

Obtaining direction

17. Explain the method of obtaining direction, which is as follows:—

Draw a line between the pivot gun and the centre of the target and measure the angle between this line and the zero line, with a protractor. Work out the switch required to lay the line of fire of No. 1 gun 22½ yards to the right of the centre of the target, in the normal manner.

18. Confirm the methods of locating the pivot gun, of placing the guns on their zero lines and of obtaining direction, by questioning the class.

Practical pegging

19. Demonstrate pegging using a reference point.

20. Practise the squad.

21. Demonstrate pegging using a compass.

22. Practise the squad.

23. Practise the squad in resecting a position and pegging it for a night shoot.

Conclusion

24. Questions to and from the squad.

25. Sum up main points.

Lesson 117.—MAP SHOOTING—ELEVATION, CREST CLEARANCE, AND SAFETY

A INSTRUCTOR'S NOTES

Aim

1. To teach how to calculate from the map the elevation required to hit the target.

2. To teach how to determine from the map whether guns willl clear the crest.

3. To teach how to ensure from the map that fire can be delivered over the heads of our own troops with safety.

Class and instructors

4. One officer instructor and not more than 30 in the class. Squad instructors, if available, can be of use in helping backward members of the class to work out map problems.

Periods

5. One 90-minute period, lecture and practice.

Stores

6. Blackboard and chalk. The class require range tables, maps marked up with the example used in Lesson 116, resector protractors and sharp pencils.

Preparation

7. Draw the diagram given below on the blackboard. Prepare two map shoots.

B CONDUCT OF LESSON

Approach

8. Give the aims of the lesson (*see* para 1, 2, 3 on page 77). Revise Lesson 116, by questions.

Obtain elevation

9. Explain that:—

(a) The range gun-target is obtained from the map using the scale on the resector protractor, or dividers in conjunction with the scale at the bottom of the map.

(b) The angle of sight is obtained by determining the difference in height between the guns and the target and converting this vertical height to an angle. (*see* Fig 53 below).

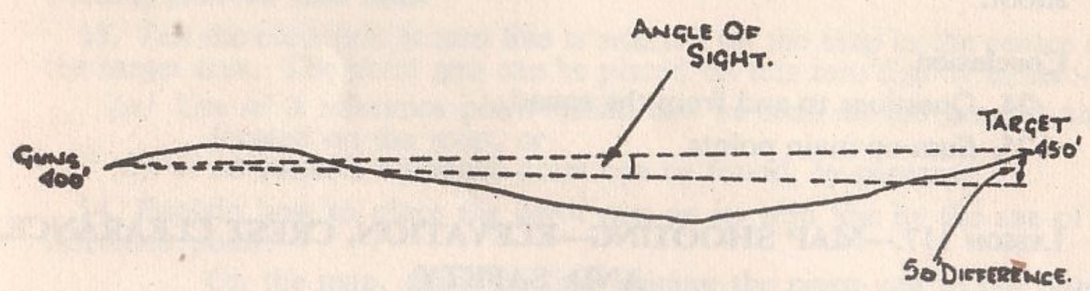


FIG 53

The procedure is as follows:—

(i) Examine the contours and note the height of the guns and the target above sea level and thus determine the difference in height between the two, *eg*,—

Target	...	...	...	450 ft.
Guns	...	...	...	400 ft.
Difference	...	...	...	+50 ft.

(ii) Convert this figure to the nearest number of yards and from the VI graph discover the angle it subtends at the range gun-target, *eg*.—

Range 2700 yards.
17 yards at 2700 yards subtends 20 minutes.
Angle of sight is plus 20 minutes.

(c) Errors in elevation are covered by the combined sight rule in the normal manner.

10. Get the class to work out an elevation problem.

Crest clearance

11. Explain that it may be necessary to ascertain whether the bullets will clear a crest which is not visible from the gun position. The line on the map between the gun line and the target should always be examined to see if it passes through a contour higher than the guns. If such a crest is found, the procedure is:—

(a) By comparison of the contours, determine the difference in height between the crest and the guns, and measure the range guns-crest.

(b) From the VI graph discover what the height of the crest above the guns subtends as an angle. This is the angle of sight to the crest.

(c) From the range tables, find the crest clearance angle for the range guns-crest.

(d) Add these two angles together and the MQA is obtained. By comparing the MQA with the lowest quadrant angle required to engage the target, it can be ascertained if the guns will clear the crest.

Example:—

Range guns-crest	...	...	...	1200 yards.
Gun contour	...	...	...	400 ft.
Crest contour	...	...	...	500 ft.
Difference	...	...	...	100 ft.
33 yards at 1200 subtends			...	1° 35′
Crest clearance angle at 1200 yards				1° 36′
MQA is	...	...	...	3° 11′

From the previous example, the elevation to hit the target was 2700 plus 20′. Lowest elevation required would be 2600 plus 20′.

Tangent angle for 2600 yards is	...		5° 24′
Angle of sight is	...	...	20′
Lowest quadrant angle is	...	...	5° 44′

By comparing this with the MQA it can be seen that guns will clear the crest by 2° 33′.

12. Get the class to work out a crest clearance problem.

Safety

13. Explain that it may be necessary to ascertain whether the guns can be fired with safety over the heads of our own troops in the line of fire. The procedure is identical to the procedure for ascertaining if guns will clear a crest, except that the safety angle for the range guns-own troops is employed in place of the crest clearance angle for the range guns-crest.

Example:—

Range guns-own troops ...	...	850 yards.
Gun contour	...	400 ft.
Own troops contour ...	...	640 ft.
Difference	...	240 ft.
80 yards at 850 yards subtends ...		5° 20′
Safety angle at 850 yards is ...		1° 57′
Guns must not fire lower than ...		7° 17′

14. Get the class to work out a safety problem.

15. The class should now be practised in the whole procedure of making calculations and preparing positions for map shoots. It is advisable for the instructor to check that the class have obtained the correct data before allowing them to prepare the fire order.

Conclusion

16. Questions to and from the squad.

17. Sum up main points.

LESSON 118.—FIRE CONTROL CHARTS

A INSTRUCTOR'S NOTES

Aim

1. To teach the use and method of compiling fire control charts.

Class and instructors

2. One officer instructor and not more than 30 in the class.

Periods

3. One 45-minute period, lecture.

Stores

4. Blackboard and chalk and a supply of fire control charts, Army Form B 2668 (*see* Plate 24).

Preparation

Draw a specimen fire control chart on the blackboard.

B CONDUCT OF LESSON

Approach

6. Give the aim of the lesson (*see* para 1 above).

7. State that for the conduct of programme shoots, when fire is required at stated periods on one or more targets, it will generally be preferable to issue charts for the control of fire. Such charts are usually desirable for shooting off the map and firing by night.

Compiling fire control charts

8. Fire control charts are made up by group commanders. They are prepared from data obtained during reconnaissance. Normally during programme shoots by day or night section commanders command their own sections under the supervision of the group commander. Fire control charts are therefore required for the group commander showing the data for all four guns, and for each section commander showing the data for their respective guns.

9. Explain each heading of the fire control chart. The charts contain the actual detail of switches, timings and rates of fire and the elevations and number of taps to be employed for each target.

State that time must be allowed in the chart for the lifts and switches to be put on the guns. At night a pause of 30 seconds should be allowed for each lift and 60 seconds for each switch. When tapping right and left is required, the time taken to complete the series of bursts and taps should also be allowed for.

In prolonged shoots, pauses should be allowed for the maintenance of the guns. These pauses should be arranged so that never more than one gun is stopped for this purpose.

An example of a completed fire control chart is shown in Plate 24. Columns 7 and 9 should not be completed initially, as the angle of switch and the elevation should not be corrected for climatic conditions until the guns are about to fire on a task.

Conclusion

10. Questions to and from the class.

11. Opportunity should be taken of practising fire controllers in compiling fire control charts, when working out map shooting or night firing problems.

12. Sum up main points.

Army Form B2648
(Pads of 50)

M.M.G. FIRE CONTROL CHART

No. A.b.h. Gun — Magnetic Bearing of Zero Line 8° — No. ..... PLATOON — Angle of Switch to Corrected Zero Line .....

Number of Task (1)	Clock Time From (2)	Clock Time To (3)	H Time From (4)	H Time To (5)	Angle of Deviation From Zero Line (6)	Corrected Angle of Deviation From Zero Line (7)	Elevation or Depression (8)	Corrected Elevation or Depression (9)	Taps R & L (10)	Rate of Fire (11)	Lifts (12)	Number of Belts or Time for Each Elevation (13)	Remarks (14)
1	0414	0424	H	H+10	4°10' L		1100 +5' (1+2 GUNS) 1100 +15' (3+4 GUNS)		2	R	–	8 BELTS.	
2	0430	0445	H+16	H+31	3° 40' R		2550 -20'		3	N	– D 50 U 100 D 150 U 200	2 BELTS 1 BELT 1 " 1 " 1 "	POINTS DURING FIRING AFTER THIS TASK.
3	0510.	0525	H+56	H+71	3° 40' R		2550 -20'		3	N	– D 50 U 100 D 150 U 200	2 BELTS 1 BELT 1 " 1 " 1 "	—

Date 13 APR ..... (Sgd.) ..... Commanding ..... No. ..... Platoon

PLATE 24

RESTRICTED